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Man
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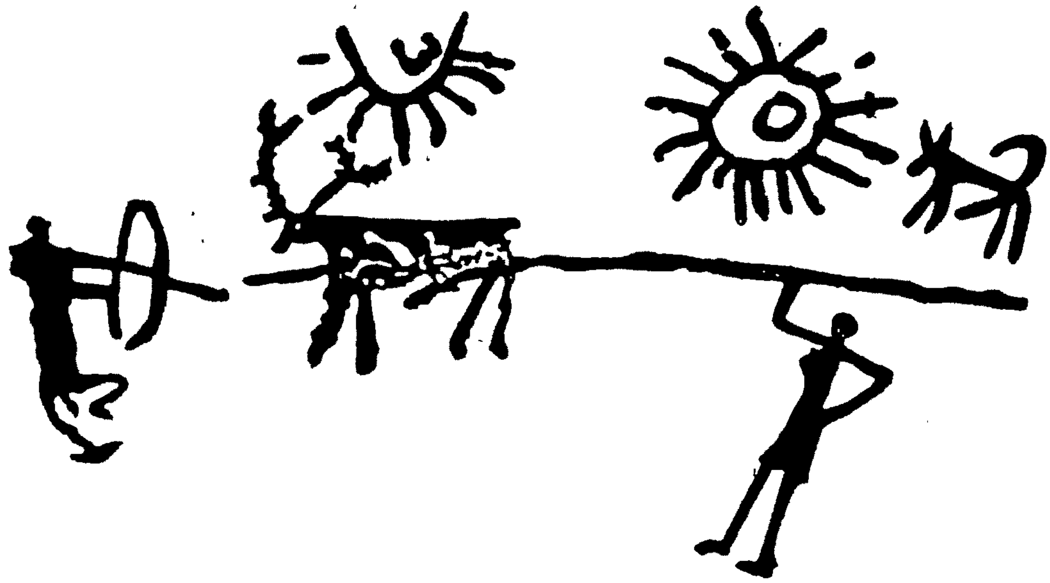

Indian Society for Prehistoric
and Quaternary Studies

Indian Society for Prehistoric and Quaternary Studies
c/o Department of Archaeology
Deccan College Post-Graduate and Research Institute
Pune 411 006 India

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Editorial

This issue of MAN AND ENVIRONMENT is being brought out under exceptional circumstances. Dr. Dilip K. Chakrabarti who has been editing the Journal was invited as Visiting Professor to the newly-established Archaeology Programme at Jahangirnagar University, Bangladesh. As Dr.Chakrabarti was in a state of uncertainty about the date of his joining his new position, he was unable to send the manuscript to the press. Eventually it was agreed that the present volume should be printed in Pune. We received the papers from Dr.Chakrabarti only at the beginning of October. This left us little time to satisfactorily edit the papers and get them printed. We trust that our readers will appreciate the constraints under which this volume has been brought out and consequently overlook its shortcomings.

We would like to place on record the gratitude of the Executive Committee and all members of the Society to Dr.Chakrabarti for so ably editing the Journal for the last nine years. Dr.Chakrabarti has been editing the Journal and seeing it through the press without either professional or secretarial assistance at his disposal. Singlehanded, he did all the editing, proof-reading and correspondence. Yet, in spite of these limitations, Dr.Chakrabarti saw to it that the Journal always appeared in time for the Annual Conference of the Society. We know there were occasions when Dr.Chakrabarti sat up in the press over several nights, reading the proofs, and on one occasion at least, with a high temperature. We deeply appreciate Dr.Chakrabarti's contribution in sustaining the Journal through difficult times.

We are happy to inform our members that the Ford Foundation, New Delhi has given a generous grant to the Society for use over a period of five years We are grateful to Shri V.C.Joshi and Dr.Tom Kessinger, formerly Project Consultant and Representative of the Ford Foundation respectively for the award of this grant. The grant is meant to bring out the journal twice a year, instead of once a year as at present, as also to improve its editorial and printing quality. This will be possible not only because of the greater funds available, but also because of extra editorial expertise and secretarial assistance, including Word Processing facility, available at Pune. It will be our sincere endeavour to continue to improve the quality of the Journal in every respect. However, this goal can only be realized with the active cooperation of all members of the Society.

The Journal will henceforth be printed and distributed from Pune in June and December every year. All manuscripts will be refereed by experts and the referees' advice will be a decisive factor in their acceptance.

We have drawn up detailed guidelines for potential contributors to the Journal. These have been printed at the end of this volume. We request our contributors to follow these guidelines scrupulously while preparing their manuscripts. Their cooperation in this matter will minimise delay in the preparation of the press-copy and therefore help in bringing out the Journal on time. Since all papers will now necessarily be refereed, it will be appreciated that there will be a time lag of at least six months between the receipt of the papers by the editors and their publication. Contributors are therefore requested to send in their papers as soon as they are ready and not too close to the desired date of publication.

We look forward to the enthusiastic cooperation of our members as well as other contributors.

The publication of this Journal has been financially supported by the Indian Council of Historical Research (ICHR) and Archaeological Survey of India (ASI). The responsibility for the facts stated, opinions expressed, or conclusions reached is entirely that of the contributors of the articles. The ICHR and ASI accept no responsibility for them.

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History of Vegetation of Peninsular India*

V.M.Meher-Homji
French Institute Pondicherry

Introduction

India began to attain its present shape and familiar geographic features towards the close of the Cretaceous. Peninsular India had a large islandic configuration; a narrow seaway, the Trans-Deccan Straits connected the west coast of India to the south-eastern margin of the Peninsula (Sahni 1984:Fig. 1). The climate was oceanic, equable. Estuarine and fluviatile conditions existed in Gujarat, Madhya Pradesh and the Deccan. The tract between Bijapur-Gulbarga to Kathiawar was repeatedly inundated by lava flows. The volcanic activity continued from the Late Cretaceous to the end of the Eocene. Peninsular India continued to remain a large island with an equable climate in the Eocene times (Vishnu-Mittre 1969).

Considering the global scenario, the fossil leaf impressions that may be definitely referred to as angiosperms (flowering plants) are known from the Early Cretaceous horizons. Their abundance and diversity increases in the Upper Cretaceous. Their sudden appearance is an enigma. Many palaeobotanists are of the view that their origin should be much earlier than revealed by the fossil records. There is some scanty disputed evidence of their existence in the Jurassic or even in the Triassic. Unfortunately, the probable ancestors of the group have not been preserved.

In India, the Cretaceous horizons have not yielded any fossils of flowering plants, though they do show the presence of ferns and gymnosperms. The earliest known angiosperms in India have been recovered from the Deccan Intertrappean beds of Chhindwara, Nagpur and Mandla districts in Central India which have been assigned the age ranging from the Upper Cretaceous to the end of Eocene.

Among the large number of fossils discovered from these beds, some bear a close resemblance to the present-day genera like *Ailanthus, Amoora, Barringtonia, Bischofia, Canarium, Elaeocarpus, Glochidion, Homalium, Lagerstroemia, Musa, Olea, Persea (Machilus)* and *Tetrameles* growing in the wet evergreen forests of the Western Ghats (Meher-Homji 1980a).

Some other fossils from these areas are indicators of an estuarine environment like *Barringtonia*, mangrove species *Sonneratia* and *Nypa* (a small palm, common in the Sunderbans), coconut-like palms and certain algae of saline habitat. A look at the map of India during the Cretaceous (Fig. 1) indicates the presence of the arm of a sea in Central India (Krishnan 1952; Lakhanpal 1970; Sahni 1984).

The environmental implications are, prevalence of a humid tropical climate like that of Western Karnataka and Kerala, and the vicinity of sea and creeks permitting the development of halophytic vegetation or of back-mangrove. Fossil genera like *Rodeites, Cyclanthodendron, Enigmocarpon* and all the gymnosperms of the Deccan Intertrappean beds have not been recovered from the succeeding horizons of later periods

During the Eocene period, fossils of wet evergreeen forest species such as *Calophyllum, Garcinia* and *Mesua* and the coconut palm have been known from the now arid Barmer region of Rajasthan. Another genus of the humid rainforests, *Dipterocarpus*, is collected in fossil form dating back to the Late Tertiary from Kutch.

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* Presidential address read at the XVth Annual Conference of the Society held at Dr. Harisingh Gaur Vishwavidyalaya, Sagar, M.P., December 27 - 29, 1987.

The rock magnetism of the Deccan traps indicates the position of India during the Early Eocene at about 30° S; the movement has been gradual from that position to its present one. According to Chowdhury (1965) the composition of the Eocene and Miocene flora of India is different; the former indicates affinity with the flora south of equator. Lakhanpal (1970) considers that the Tertiary flora of India are tropical in nature consisting of those genera now largely confined to the Old World. Pollen grains of pines - a temperate genus - seem to be coming from higher altitudes because its foliage, seeds and cones are missing in the fossil records. A few families of the southern hemisphere like Podocarpaceae, Araucariaceae, Proteaceae and Casuarinaceae which occur in the Lower to mid-Tirtiary seem to be the heritage of the Gondwana connection.

Miocene

The Pondicherry-Cuddalore-Neyveli area is presently clothed with thickets or the so-called tropical dry evergreen forests. However, the geological formation called Cuddalore sandstone of this region of Miocene age has yielded fossils of evergreen rain-forest genera like *Anisopteris, Cynometra, Dipterocarpus, Dryobalanops, Gluta, Hopea, Mesua* among others (Meher-Homji 1980a).

Whereas the fossils recorded from the Neyveli lignite and Cuddalore sandstone sites around Pondicherry are exclusively of angiosperms (flowering plants), one notable exception is the Tiruvakkarai area where large petrified Podocarp (conifer-gymnosperm) woods dominate. The only living conifer in South India is incidentally also a *Podocarpus* (*P. wallichianus*). Presently it occurs in the Western Ghats south of the Nilgiris at 900-1500 m altitude. In S.E.Asia and equatorial Africa too, *Podocarpus* occurs essentially in the mountains only. In the distant past it could have extended along the Biligirirangan-Shevaroy-Kalrayan-Javadi hills of Tamil Nadu and further northwards along the Eastern Ghats. As a matter of fact, fossils of Podocarps have been recently reported from the Rajahmundry area by Mahabale and Satyanarayana (1978). One of the probabilities is that the Podocarp woods have been transported by the rivers from the hills to the sites of deposition like Tiruvakkarai and Rajahmundry. Another possibility is the occurrence of a local gregarious edaphic coastal community of the Podocarps at Tiruvakkarai and Rajahmundry not unlike the present-day forests of bald-cypress (*Taxodium distichum*) of the swamps of U.S.A. (Meher-Homji 1980a).

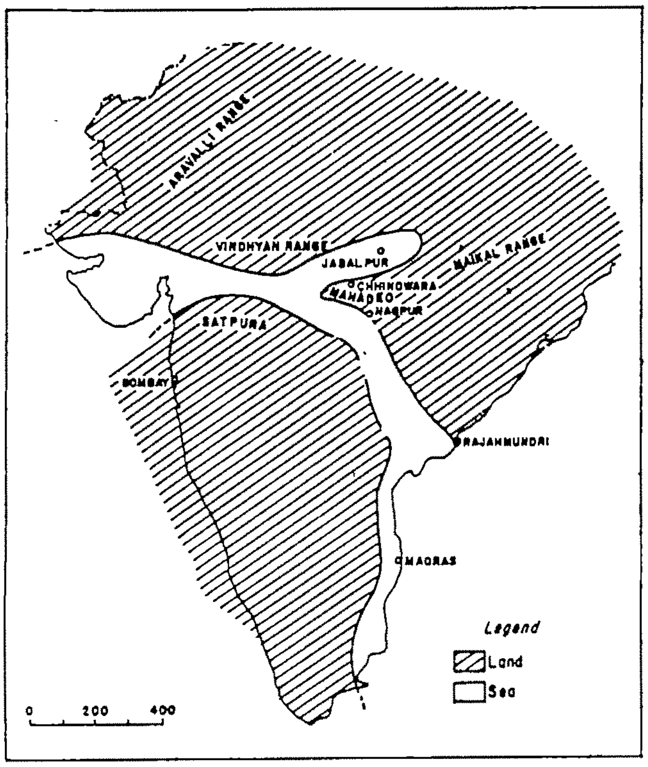

Fig. 1. Palaeogeographical Map of Peninsular India in Upper Cretaceous (After Sahni, 1984).

Plant Geographic Considerations

The view that India had reached its present position by the Early Eocene is not favoured by palaeontological facts. The fossil mammalian genus *Indohyus* collected from the Murree group (Kalakot zone) of Jammu and Kashmir State was supposed to present a certain resemblance with *Gobihyus* from the Eocene of Mongolia. However, Ranga Rao (1971) has cast doubts on the affinity and the age of the *Indohyus* fossils collected by him. Besides, the Cretaceous-Early Eocene floras of Tibet are different from those of the Deccan Intertrappeans of the same age. Therefore, the contact of the Indian and the Eurasian plates should be an event that took place after the early Eocene (Hsu 1976).

Palaeomagnetic studies of the Traps have indicated the position of Nagpur now at 21° north at 7° north, during the Miocene times. This would place South India near the equator during the Miocene times with a hot, humid climate and evergreen forests, as indicated earlier by the fossil record. Thus the movement of the Pondicherry region from near about the equator to 12°N within about 20 million years would give a horizontal drift rate of about 6 cm per year. This tallies fairly well with the rates estimated by geologists like Axelrod (1974) and Valdiya (1975).

The above rate of the post-Miocene period is somewhat slower than the rate during the preceding epoch. The study of magnetism of the Deccan Traps showed that India drifted over 50° of latitude since the time of formation of the Deccan Traps 70 million years ago. This would mean an overall drift rate of about 8 cm per year, a rate generally considered rapid enough to result in (a) extermination of most of the gymnosperms of the Indian Peninsula, (b) change in the Miocene flora of India from the earlier period and (c) poor contribution of India to modern floras in relation to its vast size.

Throughout the length and breadth of the Peninsula, from the Siwaliks in the north to Pondicherry and Warkalli-Quilon in the south and from the Bengal basin in the east to Kutch-Rajasthan in the west, plant fossils indicate the prevalence of a uniformly warm and humid climate at least till the onset of the Pliocene. By Miocene times, the sea had retreated from Central India and more or less the present day coastal configuration was attained, except that Kathiawar was a peninsula.

Pliocene

From the mid-Miocene to Pliocene, the Himalayan range was being uplifted forming a fore deep between the Peninsula and the Himalaya. The precursors of the Indus, Ganga and Brahmaputra were probably in existence by then.

The northward movement of the Indian plate brought about a major change in the climate, not only because it crossed the equator and was deprived of the equatorial climate characterised by daily rainfall but also because in the wake of its collision with the Asian mainland, the Himalayas were uplifted and the present day monsoon pattern was established. Almost at the same time, during the Pliocene, the Western Ghats were elevated and they also contributed in bringing about a climatic change by way of creating a rain-shadow effect on the leeward side of the Ghats. The rainfall of the Coromandel coast and the Deccan was drastically reduced with a parallel increase in the length of the dry season; the vegetation changed from wet evergreen forests to thorny, shrubby thickets. In the forests of the Peninsula, the evergreen species were replaced by the deciduous ones everywhere except in the Western Ghats and Assam where the rainfall conditions continued to be favourable to the former (Meher-Homji 1980a).

Whereas the major portion of the Indian subcontinent experienced a climatic change in the Tertiary, south-east Asia has retained a more or less uniformly humid climate. The pollen stratigraphy suggests that in this central part of the Indo-Malaysian region, plant evolution has continued uninterrupted by any major climatic shift since the Cretaceous (Muller 1970). Aubreville (1969) proposed that the Tertiary equator was not far from the present-day equator in south-east Asia and so the vegetation did not experience much change compared to Africa. Melville (1966, 1967) ascribes the climatic change in India to its rapid and exactly south-north drift. This eliminated most of the Cretaceous gymnosperms (Florin 1961) and accounted for small contribution of India to its modern flora in spite of its size, as compared to south-east Asia and Africa.

As India joined the Asian mainland, connections were established first in the north-west probably by mid-Eocene and later on in the north-east. Fig.2 shows the position of the drifting Indian plate in the Cretaceous, at the end of the Palaeocene and at the end of the Eocene. Interexchange of species was facilitated with these connections. The climate being tropical humid in Eocene-Miocene, the entry of the Malaysian species was favoured. Incidentally, the recent palaeomagnetic findings reveal that the Malaya-Indonesia archipelago was not a part of the drifting South Asian plate and hence of Gondwanaland (Fig.2). Earlier, Malaysia was considered a part of the moving Indian plate that later got separated along the line of Ninety-East fault and moved to the north-east.

The Other View

The existence of two continents - Gondwana and Laurasia, the extent of the Tethys sea, the plate tectonics and the origin of the Himalaya due to collision of land-masses are some of the aspects that have been questioned.

The concept of Gondwanaland is not accepted universally and some palaeontologists favour Wegener's (1929) view of a single continent, Pangaea, surround by an ocean called Panthalassa. They point out that the intermingling of Gondwanian, Angaran, Cathaysian and Eur-American flora and fauna during the Permian cannot be treated as freak events of parallel evolution or chance transport as a large number of genera are involved. New data suggest that there were no constraints on the migrations of plants and animals between the four biogeographic regions, suitability of habitat being the only limitation for their distribution.

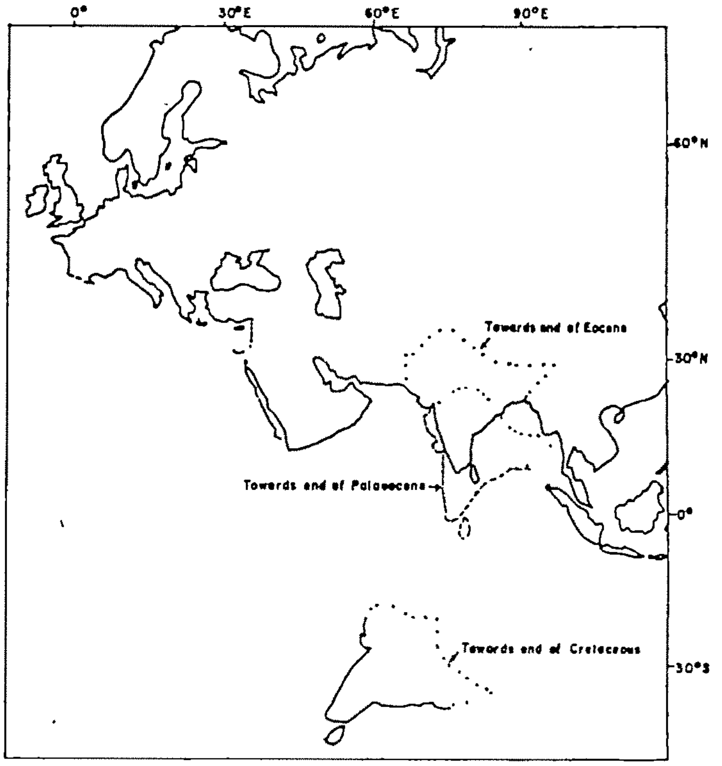

Fig.2. Positions of India Relative to Eurasia towards End of Cretaceous, End of Palaeocene, End of Eocene (inspired from Smith, 1974)

Glacial deposits of the late Palaeozoic age, long considered to be the unique feature of the continents forming Gondwanaland, are now reported from a number of localities on other continents.

The role of the Tethys is much reduced. It is not considered as an oceanic basin in the Palaeozoic times, extending across the present Himalayan belt, separating India from Angaraland. The Tethys is envisaged as an intermittent epicontinental sea, existing as a longitudinal gulf separating Europe from Siberia with eastern Turkey, northern Iraq, southern Afghanistan, Salt Range and Spiti lying on the continental shelf. In the Permian, branches of this sea covered Pakistan, Iran and Arabia extending southwards to Tanzania and Madagascar. Another branch extended eastwards across the belt now occupied by the Himalaya and was connected with the Pacific.

A series of plant beds have been discovered in recent years in the Devonian and Carboniferous sediments of Kashmir, which suggest continental facies with several marine transgressions as opposed to the prevalent view of their being entirely marine. The plant fossils bear a close similarity to those of the Northern Continent hinting at the continuity of these horizons with the Northern Continent.

Whereas the northward movement of India is ruled out, it is suggested that the continents, perhaps, did separate late in the Triassic when the Tethys, as an ocean way probably appeared for a short while; after this event the continents came closer together again, without actual under-thrusting or over-riding. India was rotated in counter clockwise direction by crustal sliding, without any lateral translation, around a pivot in Baluchistan between 100 and 65 million years ago.

According to this other view (Ahmad 1978), the Himalaya are not the result of the collision of land masses as postulated by the theory of plate tectonics but they are an inter-platform type of mountain range formed by vertical uplift. Recent deep seismic soundings in the Pamir area reportedly indicate that the area is not formed by welding of two land masses. The causes of the vertical uplift of the Himalaya are not yet clear but according to Ahmad it could be the progressive downwarping of the Indo-Gangetic basin, resulting in the migration of the subcrustal material to the adjacent belts on the two sides, Himalaya on the one hand, and the Assam plateau and the Vindhyan-Aravalli ranges rising cogenetically, on the other.

Several geomorphologists like Carey (1976), Kremp (1977) and Ahmad (1978) are of the opinion that if Pangaea and a single sea (Panthalassa) of a size smaller than the present Pacific covered the entire globe in Pre-Jurassic times, the earth must have been of a considerably smaller diameter then. The equatorial circumference of the earth may have been shorter by about 8000 to 10,000 km in the Triassic (about 180 million years ago), giving a tentative rate of spreading of about 5 cm per year. Incidentally this rate compares favourably with the horizontal drift according to the plate-tectonic theory mentioned earlier. It is the expansion of the earth that has resulted in fragmentation and separation of the continents, according to the second theory.

Quaternary and the Role of Palynology in Reconstructing the Vegetational History

The fundamental events of the Quaternary were marked fluctuations in temperature in the northern latitudes. These involved three distinct glacial periods followed by warm periods, the interglacials. The altitudinal limit of the eternal snow fluctuated a great deal during the glacials and the interglacials affecting the zonation of the vegetation belts in the Himalaya. The last glaciation terminated about 10,000 years ago.

The temperate species from north, west and east colonised the Himalaya, among these a number of conifers. The glaciation in the Himalaya also helped the migration of a few species from the Himalaya to the higher hill-tops of South India and Sri Lanka. Though no part of peninsular India experienced glaciation, the temperature may have been lowered by about 6°C. The continuity of the hill ranges from the Himalaya to the Western Ghats through Assam, Bihar, Chota Nagpur, Eastern Ghats, Vindhyas and Satpuras favoured genera like *Rhododendron, Gaultheria and Mahonia* to reach Ootacamund, Kodaikanal and the mountains of Sri Lanka.

The first glaciation changed the vegetation pattern in the Kashmir Valley according to Vishnu-Mittre (1969). The deodar and the oaks that dominated the hills were replaced by the bluepine, *Pinus wallichiana*. The changing environment due to the glacial and interglacial modification also gave rise to new species and varieties as an example of which Vishnu-Mittre (1969) quotes the case of cedar; *Cedrus libanica* which spread from West Asia into India during the Pleistocene and emerged as a distinct species, *Cedrus deodara*.

The glacial history also favours the immigration of the European, Siberian, Chinese and Japanese extra-tropical plants into the Himalaya. Takhtajan (1969) considers the Eastern Himalayas, Assam, Yunnan, Upper Burma, North Viet-Nam and Eastern Asia as the primary centre of origin of the temperate flora of the northern hemisphere, not simply as a refugium of relicts or secondary centre of development. The reason is that in this region are found entire phylogenetic series linking temperate forms with sub-tropical and tropical ones.

For the study of Quaternary vegetational history, palynology i.e., the study of pollen grains, is a precious aid in reconstructing the sequence of succeeding plants. The outer coating or exine of the pollen grain has the consistency of nylon and therefore remains preserved in sediments. Moreover, the morphological features of the pollen grain lead to the identity of family, genus or even species in some cases. By means of a borer, cores of sediments are obtained from peaty soils and lake bottoms where the pollen grains have been preserved. By analysing the profile of sediment for its content of pollen grains and dating the samples by C^{14} method, the succession of vegetation can be traced. Such palaeo-palynological studies have been carried out in various regions of the Himalaya, South Indian hills, Rajasthan and mangrove sediments of Tamil Nadu.

For the Konal Ar basin of the Nilgiri hills, Vasanthy *et al.* (1980), find no major change in the vegetation pattern over the last 10,000 years. The present day grassland-dominated landscape around Kodaikanal is in evidence even in the prehistoric time and so man alone cannot be blamed for the creation of the grasslands of the South Indian hills at the expense of forests.

Gurdip Singh and his colleagues (1974) on the other hand report large scale vegetation and climatic changes in the now arid Thar desert based on the record of fossil pollen grains from the lakes of Western Rajasthan. The palaeo-palynological evidence combined with geomorphological data reveal five arid phases alternating with four moister stages during the Holocene.

The drier phases occurred during (1) Pre-Middle Stone age, (2) Upper Palaeolithic i.e., pre-8000 B.C., (3) Pre-Harappan times i.e., 7500 B.C. to 3000 B.C., (4) Ca. 2000 B.C. to 1400 B.C. and (5) early centuries A.D. to the present. In between these phases, there were spells of lesser aridity during (1) the Middle Stone Age, (2) Ca. 8000 B.C. to 7500 B.C., (3) Harappan phase Ca. 3000 B.C. to 2000 B.C. and (4) Ca. 1400 B.C. to 1000 B.C. However, a critical interpretation of the palynological data by Vishnu-Mittre (1974) and Meher-Homji (1980b) suggests changes in aridity-humidity on a much smaller scale. According to Francfort (1987), surface observation of ancient hydrogeographic network and the study of stratigraphy of the unbricked walls of wells clearly show that the dried up rivers were active at the end of the last glaciation, well before the protohistoric settlements in the Indian Valley. Aeolian sands, carbonates etc. go in favour of arid climate. The region was populated in a climate not different from today; remnants of canals prove dependence on artificial irrigation for cultivation. *The onset of aridity in the Thar has been a late Tertiary event linked to physiographic causes like the uplift of the Himalaya.

How the glacial and interglacial phases affected the wind directions and the vegetation patterns in the deserts surrounding the Arabian Sea has been brought out by the elegant palynological investigation of Van Campo *et al.* (1982). Collection of pollen grains with air-filters on ships in the Arabian Sea revealed dominance of Cyperaceae, Euphorbiaceae, *Podocarpus* and *Olea* in summer brought by the south-west winds from East Africa. On the other hand, pollen grains of Chenopodiaceae and *Artemisia* prevailed in winter when the winds blow from the north and north-east over Arabia, Iran and Baluchistan. This pollen pattern linked to seasonal reversal of wind systems has been used by Van Campo *et al.* (1982) in deciphering the climatic trends and the status of soil salinity in the desert regions through the analysis of the fossil pollen grains obtained from off-shore marine cores in the Arabian Sea.

During the period extending from Holocene to 128 Kyr B.P. the glacial intervals corresponded to low sea-level, increasing the salinity of the littoral zone; this phase is marked by the predominance of halophytic Chenopodiaceae and steppic or arid zone species like *Artemisia*. The glaciation in Central Asia intensified the north-east winds at the expense of the south-west system, depositing large amounts of pollen of Chenopodiaceae and *Artemisia* in the Arabian Sea. The interglacial phases, on the contrary, intensified insolation and low pressures over the tropical continents, strengthening the south-west winds and the monsoonal rains; this less dry stage is indicated by an increase in the frequency of the East African pollen taxa in the Arabian Sea core profile.

Based on the pollen representation of the mangrove vegetation in the sediments of two marine cores off the South-West coast of India, Van Campo (1986) recognises two important phases of monsoon climate. The low mangrove pollen frequency in a period dating back to 22,000-18,000 years B.P. would be indicative of a dry phase when due to a weak monsoon, the run-off of the Western Ghat rivers would be reduced. This dry phase was followed by a humid phase culminating around 11,000 years B.P., with very high mangrove pollen representation linked to heavy run-off.

The changes taking place in the mangrove vegetation of the Kaveri delta of Southern India over a period of the last 2000 years due to natural geomorphic processes and anthropogenic interference has been investigated by Tissot (1986).

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* According to Francfort (1987), surface observation of ancient hydrogeographic network and the study of stratigraphy of the unbricked walls of wells clearly show that the dried up rivers were active at the end of the last glaciation, well before the protohistoric settlements in the Indian Valley. Aeolian sands, carbonates etc. go in favour of arid climate.
The region was populated in a climate not different from today; remnants of canals prove dependence on artificial irrigation for cultivation.

At Muthupet, four periods have been identified based on the representation of pollen grains of mangrove species and of back-mangroves observed in the sediments; the importance of marine influence has been indicated by a relatively high percentage of Foraminifera organic tests and dinoflagellate cysts.

These periods, from the oldest to the most recent are :

- Period A : mangrove and back-mangrove species are poorly represented, some pollen of Rhizophoraceae and Sonneratiaceae families totally absent from the landscape nowadays, are observed. Marine influeaceis clear and constant.

- Period B : marine influence increases; gradual expansion of the mangrove is also observed.

- Period C : marine influence decreases substantially, when the mangrove with dominance of *Avicennia* reaches its maximum extension.

- Period D : marine influence is cut off and herbaceous halophytes of the back-mangroves spread over a large area to the detriment of arborescent genera of themangrove which either decrease (*Avicennia*) or disappear completely (*Rhizophora, Sonneratia*).

The age of the oldest sediment in the Cauvery delta, is estimated to be about 2000 years from various arguments such as 14 C dating. The maximum Holocene transgression occurring about 5000 years B.P. and the appearance in the cores of pollen of *Casuarina* which was introduced into India in 1798 (Santapau 1966).

In order to understand the vegetational evolution observed in the cores of Muthupet, Tissot (l.c.) traces the history of the lagoon formation.

According to Ahmed (1972), all along the coast of the Cauvery delta, the dominant action of waves and coastal currents induce the formation of a sand bar, behind which a lagoon is created. Then, this lagoon is filled up more or less quickly by fluvial deposits. Beyond this sand bar fluvial sediments continue to be carried to the sea, and are reworked by the waves leading to the formation of a new sand bar and a new lagoon behind it.

At the bottom of the core in (period A), the site is located near the sea, as indicated by the constant occurrence of marine micro-organisms. In the lagoon, the mangrove which has only limited areas for spreading, expands to a very small extent. As the lagoon fills up with fluvial supplies, the mangrove begins to spread out on the banks of the recently formed channels (period B); marine influence also increases. Filling up continues, the channels become more and more numerous and the mangrove colonizes their banks reaching its maximum extent, while marine action decreases.

Then, in an area where the sea-water has no influence, arborescent species of mangrove disappear and are replaced by back-mangrove species (period D). It is possible that, during period D, human impact has slightly hastened this natural process, but palynological results do not show evidence of it.

At Pichavaram, as at Muthupet, two cores were taken, but in an area closer to the shoreline :

- One in the Avicennia forest, about 50 m from a channel bank, at a depth of 3.90 m.

- the other, 6.90 m deep, was cored on the opposite bank, very close to the channel, under *Rhizophora, Bruguiera* and *Ceriops*.

Tissot (l.c.) observed that the periods A and B are practically identical to those described for Muthupet. However, from the beginning of period C, dated from about 150 years B.P. due to the presence of *Casuarina* pollen, the evolution of palynological assemblages is different. Whereas, in Muthupet, period C corresponds to the maximum extension of the mangrove, here, pollen percentages of the three main genera, *Sonneratia, Rhizophora* and *Avicennia* decrease, while pollen of back-mangrove species show high percentages. The abundance marine microfossils in these levels proves that this stage represents the bottom of period C of Muthupet.

Therefore, period D, which in Muthupet corresponds to a rapid decrease of arborescent mangrove species and favours large scale extension of back-mangrove species, is not observed in Pichavaram.

The decline of mangrove vegetation at Pichavaram inspite of its being a Reserved Forest since 1880 might be ascribed to heavy anthropic pressure (collection of fire-wood, grazing, fishing). Besides, the Coleroon river linked to the mangrove lagoon has been dammed for providing irrigation, thus depriving the mangrove of fresh water supply at critical stages and resulting in increase of salinity.

Man's Impact on the Vegetation Since the Neolithic

So far the destiny of the flora was determined by geographic causes, climatic changes and edaphic factors. But with the appearance of man and especially with the introduction of agriculture since the Neolithic period (dated in India to 4500 years from now), the anthropogenic influence has been manifesting itself as the most dominant factor leaving its imprints on the landscape. Fire was a very powerful tool in the possession of man even before the use of iron or copper implements was known. He indulged in large scale deforestation; periodic fires, and the pernicious practice of shifting cultivation reduced the virgin forests to the status of scrubs and grasslands. Intensification of agriculture resulted in the spread of exotic weeds in fields, wastelands and along road-sides. Some weeds like *Amaranthus spinosus, Cassia tora* and *Lantana* follow human habitations; the most notorious case today is that the obnoxious weed 'Congress grass' (*Parthenium hysterophorus*) spreading itself at the speed of fire in disturbed areas.

Currently, the forest area of India covers barely 10 per cent of the total area, while the optimum is considered as 33 per cent at the rate of 60 per cent in the hills and 20 per cent in the plains. In the dry regions the so-called 'reserved forests' are nothing but degraded thickets subject to illicit exploitation and grazing.

The influence of man on the vegetation has been mostly on the destructive side through the agency of the axe, fire and domesticated animals. Even when his action is protective like the silvicultural operations, only a few economic species like teak (*Tectona grandis*) rosewood (*Dalbergia latifolia*), sal (*Shorea robusta*) and pine are favoured at the expense of many others. Thus, most of the forest works under the forest management are no longer near their original state. The present day forests with their dominance of single species like teak, sal or pine are the outcome of selective treatment by the Forest Department.

The intensive phase of destruction of forests in India started towards the end of the 18th and beginning of the 19th centuries. Tea and coffee plantations were introduced on a large scale in the Western Ghats, Sri Lanka and Darjeeling Systematic exploitation of the timbers, notably teak, started about the same time. For instance, in 1799, 10,000 teak trees were cut in Malabar for the Government of Sri Lanka.

The network of railways was intensified after 1857. Each rail track of 80 kms required 20,000 tonnes of wood, almost exclusively of teak in the southern states and of sal in the north and east. The density of the network would give an idea of the toll of the forest species taken by the railways.

Several species of *Eucalyptus* are used in plantations throughout India. *E. globulus* was introduced in the Nilgiris in 1843. In 1910 other species followed : *E. pilularis, E. eugenioides, E. paniculata, E. creba, E. acmenoides*. In 1866 *Eucalyptus* spp. were tried in Lucknow; *E. camaldulensis, E. tereiticornis* and *E. citriodora* gave good results in the plains and E. globulus in the Siwalik. *Eucalyptus tereticornis* is extensively planted in the plains.

The Australian wattles *Acacia mearnsii, A. dealbata* and *A. decurrens* were planted as ornamental trees on the South Indian Hills about the middle of the 19th century. The bark yields tanning materials. *Acacia monoliformis* is gaining importance in Bihar.

Plantation of the quinine yielding tree *Cinchona succirubra* on the western slopes of the Nilgiris deserves a mention. Those of tea, coffee and *Hevea* (rubber) have been carried out at the expense of humid forests. *Hevea brasiliensis* is planted between 500 and 1200 m altitude. The species was first introduced in Nilambur (Kerala) in 1879 but large plantations date from 1904. Coffee plantations are situated between 1200 and 1500 m in South India. Coffee was first introduced in the Baba Budan hill of Karnataka in the 17th century by a Muslim pilgrim returning from Mecca but plantations began in 1830. They were almost totally abandoned in Sri Lanka following the invasion of the pest *Hemileia vastatrix* in 1860. The Indian plantation was not spared by the epidemic. It was partly reconstituted with *Coffea robusta* which is less susceptible than *C. arabica*. Tea plantations occur above 1500 m altitude in Sri Lanka and India. Shade is an important factor in plantations. Besides the native species like *Erythrina lithosperma, Gliricidia maculata, Albizia chinensis, A. lebbek, A. odoratissima*, the Australian *Grevillea robusta* too is largely used.

Fig. 3 shows the extension of the coffee plantations in the aforesaid regions of Southern Karnataka. A rare instance of state boundary also corresponding to forest boundary is provided in Fig.3. Whereas the Mangalore and Mercara forest divisions of southern Karnataka are densely wooded, the Wynad forest division of northern Kerala bears degraded vegetation like thicket.

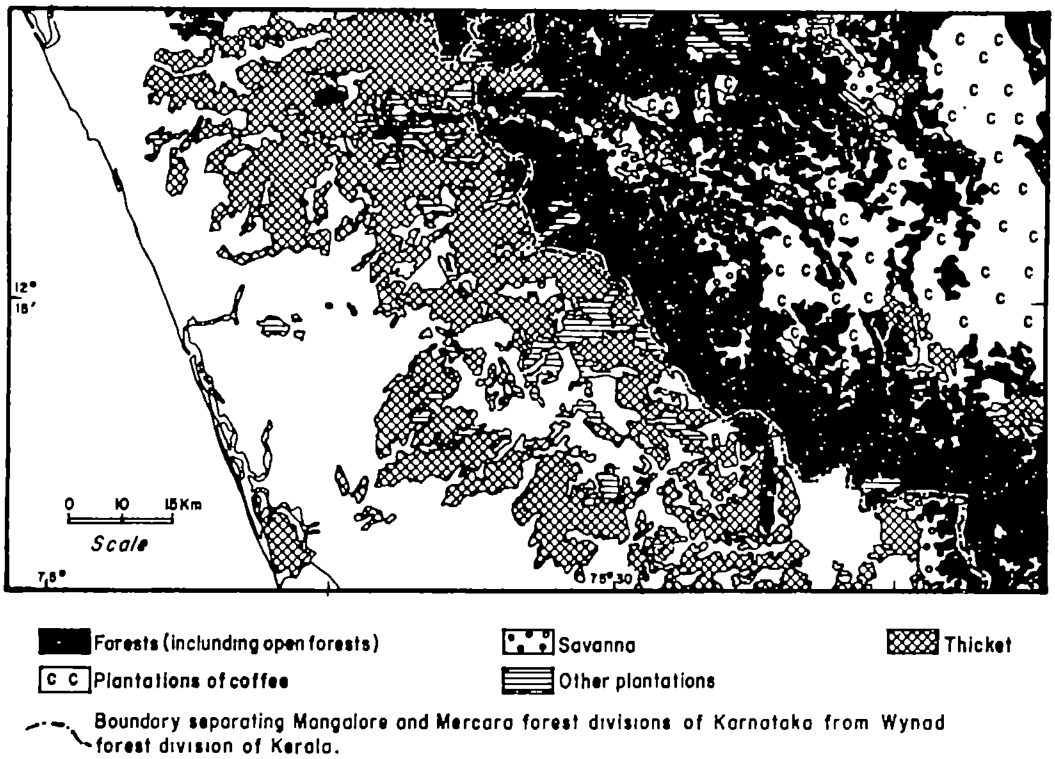
Anacardium occidentale, probably of Brazilian origin, was introduced in the 16th century by the Portuguese on the west coast of India. The species is hardy and can grow on poor soils.

Concluding Remarks

The number of living higher plants in the Indian region today exceeds 21,000 species, which is more than one tenth of the total number of species in the world. Ferns are represented by over 600 species.

Chatterjee (1939) reported that out of 11,124 species of dicoty-ledons in the Indian sub-continent, spread over nearly 1831 genera and 173 families, 61.5 per cent endemic, confined to the erstwhile territoty of 'British India', except Sri Lanka. No single family is endemic and the rate of generic endemism is low (7.3 per cent). The specific endemism of the dicotyledonous species varies from 29 per cent (3169 species) in the Himalaya to 18 per cent in Peninsular India (2045 species) and 10 per cent in Burma. The figures for endemic monocots are 1000 species in the Himalaya and half that number in South India.

Fig.3. Vegetation Contrast between Southern Karnataka and Northern Kerala (After Pascal et. al., 1982)


12°
18'
0 10 15Km
Scale
7,8°
75°30
Forests (including open forests)
Savanna
Thicket
Plantations of coffee
Other plantations
Boundary separating Mangalore and Mercara forest divisions of Karnataka from Wynad forest division of Kerala.

Hooker who compiled the Flora of British India expressed the view that the Indian region is the meeting ground of the flora from north, west and east and that it had little real botanical character of its own. Chatterjee refuted this argument from the statistics of endemic flora; about 50 per cent of plants are confined to India indicating that it has a typical flora of its own.

Various development activities like multipurpose river valley schemes, mining and railway projects result in large scale deforestation. Besides, over-exploitation of timber, fuel wood, useful plants and grazing are the factors that deplete our forests of their natural wealth. Certain species become rare and even extinct before their botanical identity is established and their economic value is known. Jain and Sastry (1979) have brought out a list of threatened plants of India which are on the verge of disappearance. Every effort should be made to preserve the few forests that are still left with their complement of flora and fauna, the rich heritage of the past.

Gadgil and Meher-Homji (1986a, b) have reviewed the main vegetation types of India, their ecological conditions, the potential area under each type, the proportion of it under forest and under other degraded vegetation and finally the key areas for conservation of biological diversity in the country.

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Facies Analysis of the Karewa Deposits, Kashmir

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Introduction

The Kashmir Valley is a bowl-shaped, rather flat intermontane valley, about 140 km long, and, at its maximum, 40 km wide. The major part of the valley is occupied by a gravel-sand-mud succession, making large plateau-like terraces, standing above the gravel and alluvium of the present-day rivers. These deposits are widely known as Karewa deposits (Fig.1).

Karewa sediments attracted mainly the Pleistocene geologists, and vertebrate palaeontologists, searching for the evidence of Early Man. The presence of well preserved plant fossils in the Karewa sediments also led to many palaeobotanical studies. These workers also made general remarks on the environment of deposition; however no attempt was made to undertake a facies analysis of these deposits along modern lines.

Tandon (1981) and Tandon *et al.* (1982) made some sedimentological studies of the Karewa deposits. Singh (1982) gave a depositional framework for the Karewa basin with some details of the facies In the present paper a short account of the depositional facies, their spatial relationship, and evolution of the basin through time is given. An up-to-date account of various studies in the Karewa basin is given by Agrawal *et al.* (1985).

Geological Framework

The Karewa sediments represent deposits of an intermontane basin The precise date of the formation of the Karewa basin is not available; but it should be sometime between Middle Miocene and Early Pliocene. On the basis of a computed rate of sedimentation, Burbank and Johnson (1982) regard the base of the Karewa sediments to be, at least, 4 Ma.

The Karewa basin (Kashmir Valley) is surrounded by mountains on all the sides The Great Himalayan Range and Saribal Range constitute the NE flank, while the Kazinag Range and Pir Panjal Range constitute the SW flank. The SW flank of the valley has risen more than the NE flank both during and also after the deposition of the Karewa sediments. Thus, better and more extensive exposures are seen on the SW flank of the Kashmir valley. Some small patches of the Karewa sediments have been raised to considerable heights in the Pir Panjal Range, and are referred to as Margs (Bhatt, 1982).

Stratigraphy

Most workers subdivide the Karewa deposits into two : Lower Karewa and Upper Karewa. Bhatt (1982) proposed a formal lithostratigraphy of the Karewa sediments where he also discusses the older schemes. The Karewa sediments are designated as the Karewa Group and this is subdivided into two Formations, namely Hirpur Formation and Nagum Formation which correspond to more or less the Lower Karewa and Upper Karewa respectively.

The Hirpur Formation (Lower Karewa) is characterized by bluish-grey clay, light-grey sandy clay, lignite, lignitic clay, coarse to medium-grained sand and conglomerates.

The Nagum Formation (Upper Karewa) shows brown and grey sandy clay, medium to coarse-grained sand, cream-coloured marl, and conglomerates, with loam or loessic sediments making the youngest lithounit of the Karewa sediments. There are no lignitic shales and grey-bluish shales in the Nagum Formation. The total thickness of the Karewa succession is about 1300 m.

The sediments of the Hirpur Formation are exposed extensively on the SW flank, but only rarely on the NE flank. The conglomerate facies (Shupiyan Member) of the Nagum Formation is well developed and exposed on the SW flank, while the mud-sand facies (Pampur Member) is well-developed and exposed in the NE flank. The loamy sediments (Dilpur Member) are present throughout the valley, forming the top of the Karewa plateau (Fig.2).

Dynamic Stratigraphic Model

The lithostratigraphic succession represented in Fig.1 can be interpreted in terms of changing facies through time and space. The first point which becomes evident is, that the SW flank has risen extensively exposing almost the complete lithostratigraphy of the Karewa, while the NE flank has risen by a lesser degree, thus only the Upper Karewa and the top few metres of the Lower Karewa are exposed.

In the SW part, sediments of the Hirpur Formation show steeper dips near the Pir Panjal Range and become gentle to almost horizontal near the central part of the basin. This fact signifies uplift of the Pir Panjal Range with its cover of Karewa sediments. The Rembiara Member conglomerates become thin and finer grained away from the Pir Panjal

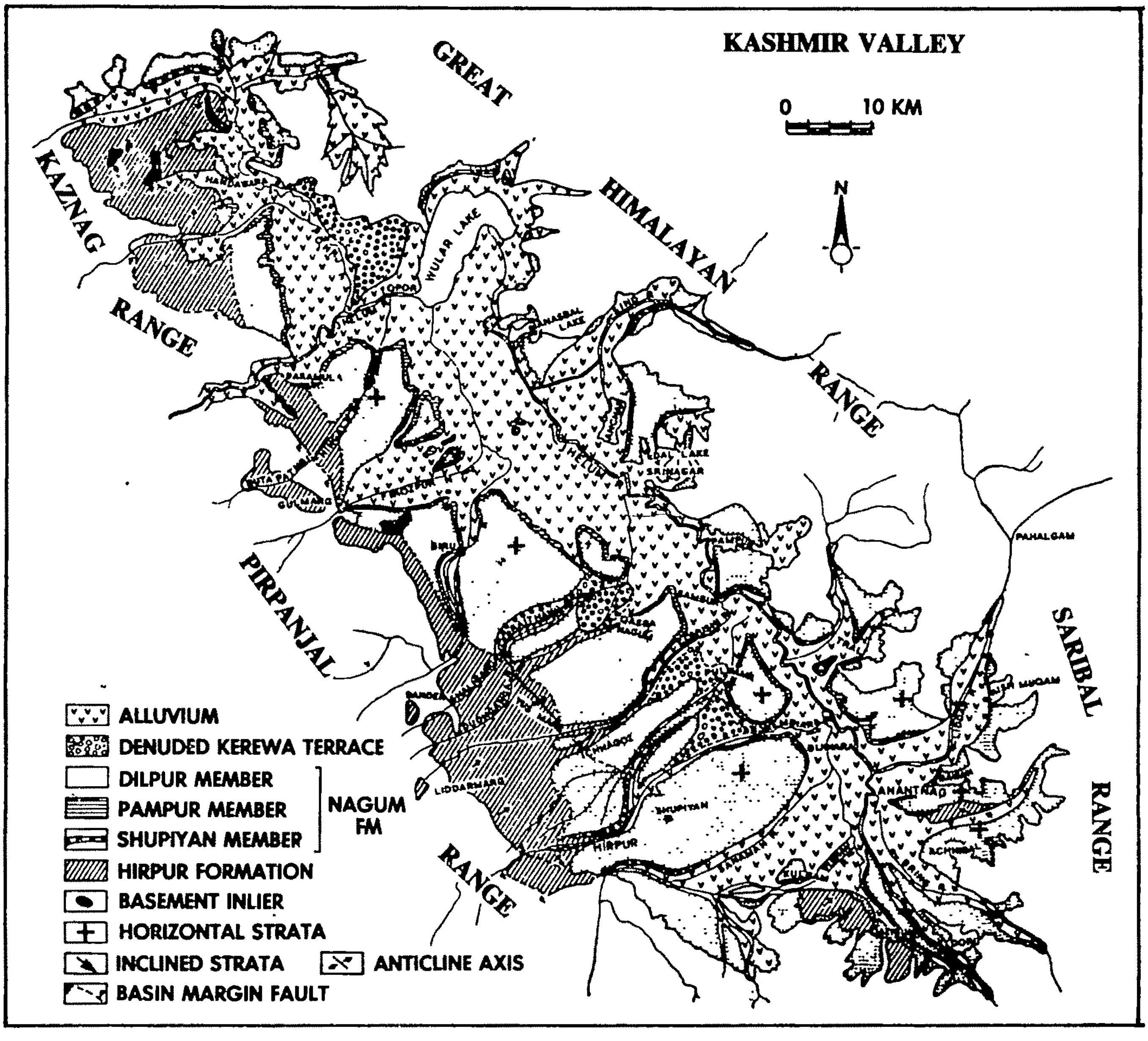


Fig. 1. Geological Map of Kashmir Valley (after Bhatt, 1982)

Range. The lower contact of the Shupiyan Member with Methawoin Member is uncomformable near the Pir Panjal Range, and it becomes conformable and even shows interfingering with the Methawoin Member towards the central part of the basin. This signifies that Shupiyan Member is strongly time transgressive, and uplift of the SW flank gradually moved towards the centre of the basin. In the central parts of the basin and upto the NE flank, the Nagum formation is represented by a clay-sand succession of the Pampur Member, which is the time equivalent of the Shupiyan Member of the SW flank. The Pampur Member locally merges into thin conglomerates near the NE flank. The loam loessic sediments of the Dilpur Member are present on different lithounits of the Nagum Formation.

This lithostratigraphic distribution of the Karewa Group can also be interpreted in a model considering the deposition of the successive sediments in the lake basin. It is postulated that sedimentation of Karewa succession was initiated with the development of the lake in the Kashmir Valley. The initial phase of deposition in the lake basin is represented by the Dubjan Member, where sand - mud cycles are related to the expansion -contraction of the lake. A major phase of tectonic uplift of the SW flank caused a heavy influx of the coarse - grained clastics, leading to the development of broad alluvial fans (Rembiara Member) and the lake basin shrank towards the central part of the valley. The quiet period following the deposition of conglomerates of Rembiara Member, led to the expansion of the lake basin again almost up to the original extent in the SW flank, and the formation of the second major lake deposits (Methawoin Member). The Methawoin Member shows many minor cycles of lake expansion and contraction related to changes in the supply of sediment from the Pir Panjal Range.

This phase of lake deposition is followed by another major uplift of the SW flank causing restriction of the lake towards the central and NE flank. While in the SW flank thick conglomerates in fan-braided stream systems were deposited (Shupiyan Member), in the NE part of the valley lake sedimentation took place (Pampur Member). Minor conglomerates of braided streams also locally developed near the sediment input areas on the NE flank of the valley.

An uplift event of the Kashmir valley, drained the lake of the upper Karewa time (Pampur Member). The surface of the valley was exposed to wind action, soil development, minor fluvial channels which led to the deposition of the Dilpur Member.

Environmental Interpretation of Karewa Sediments

A description of various types of stratified sequences found in the Karewa deposit is given in Singh (1982). A brief summary of various types of stratification sequences found in the Karewa deposits is given below and a sedimentation model for various lithostratigraphic units is also suggested.

Dubjan and Methawoin Members

Both of these lithostratigraphic units represent deposition in a lake with rather similar conditions, thus most of the stratif-

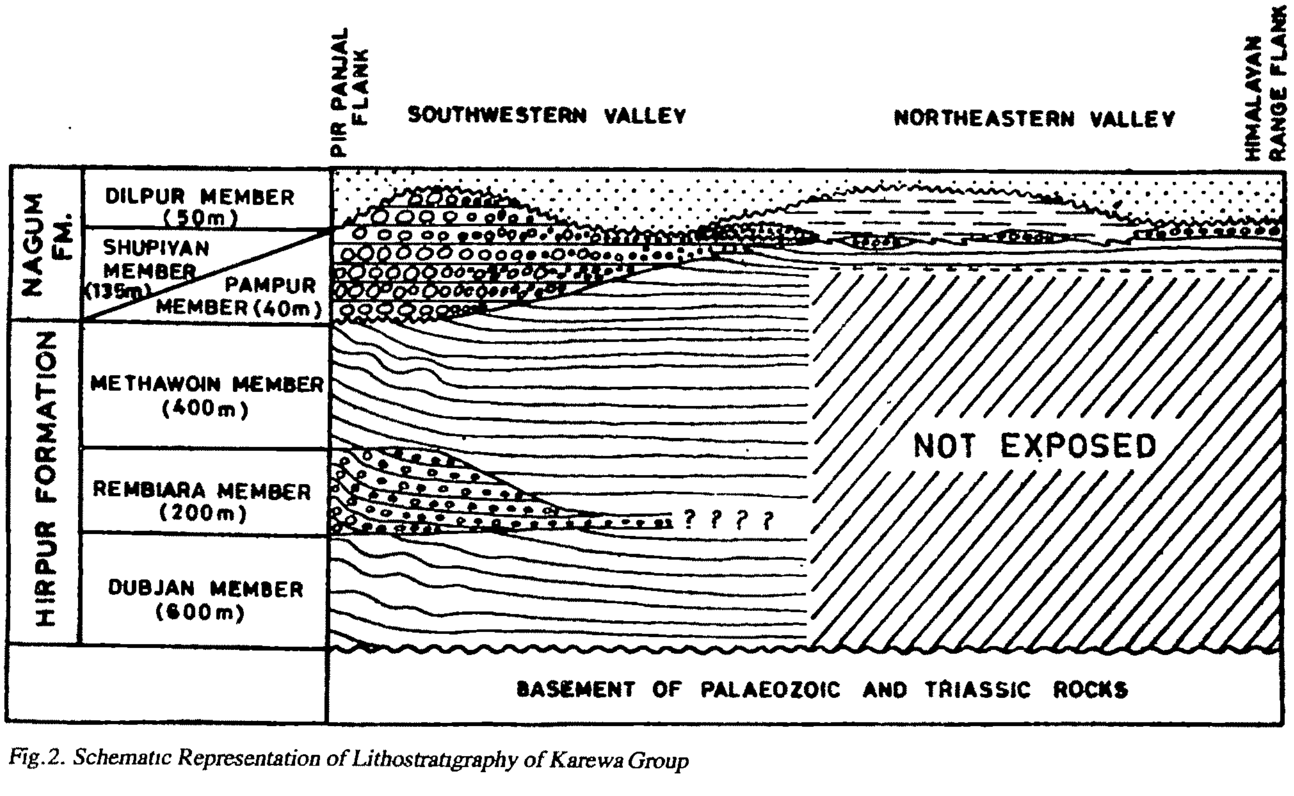


Fig.2. Schematic Representation of Lithostratigraphy of Karewa Group

ication sequences in the two are also similar. The following are the main lithologies of these sediments :

Grey, non-laminated clay - denoting deposition in a deeper part of the lake, below wave base.

Rhythmically laminated sand and mud - deposits of the shallower parts of the lake, reached by the waves. The sand layers invariably show wave ripple structures.

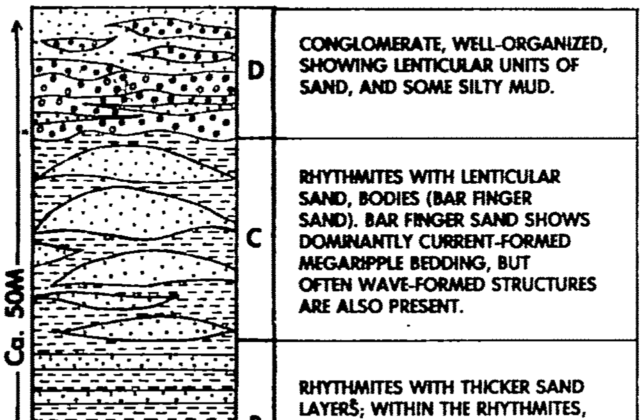
Sheet sand layers - DCm to metre thick sheet - like sand layers showing parallel lamination and some wave ripple structures. They represent deposits of sands in the subaqueous part of the lake delta (delta front).

Lenticular sand bodies - They may be a few metres thick, showing large-scale cross-bedding, sometimes a few wave-formed structures may be also seen. They are embedded in the lake-mud and rhythmite units. They are bar-finger sand bodies of subaqueous delta distributaries.

Conglomeratic channel sand - They show large-scale cross-bedding and represent deposits of braided stream channels.

Wave-rippled sand with thin mud layers - This denotes deposits of the lake beach under the influence of waves.

Lignitic mud - This is made up of mud rich in organic matter sometimes developed as lignite bands. It denotes deposition in the vegetated lake swamps surrounding the lakes.


Ca. 50M
D
CONGLOMERATE, WELL-ORGANIZED, SHOWING LENTICULAR UNITS OF SAND, AND SOME SILTY MUD.
C
RHYTHMITES WITH LENTICULAR SAND, BODIES (BAR FINGER SAND). BAR FINGER SAND SHOWS DOMINANTLY CURRENT-FORMED MEGARIPPLE BEDDING, BUT OFTEN WAVE-FORMED STRUCTURES ARE ALSO PRESENT.
B
RHYTHMITES WITH THICKER SAND LAYERS; WITHIN THE RHYTHMITES, THIN SAND LAYERS SHOWING WAVE RIPPLES ARE PRESENT. THICK SAND LAYERS ARE ALSO WAVE-FORMED.
A
GREY, NON-LAMINATED MUD.

IDEALIZED SCHEMATIC REPRESENTATION OF DUNJAB MEMBER IN NINGAL NALA SECTION

Fig.3. Idealized Vertical Sequence in Dubjan Member Formed Due to Prograding Birdfoot Delta. A - Lake Mud, B - Delta - Influenced Lake Bottom, C - Subaqueous Delta Front, D - Braided Stream.

Vertical stacking of the above-mentioned lithologies have produced several types of cycles, which can be broadly classed into three major categories :

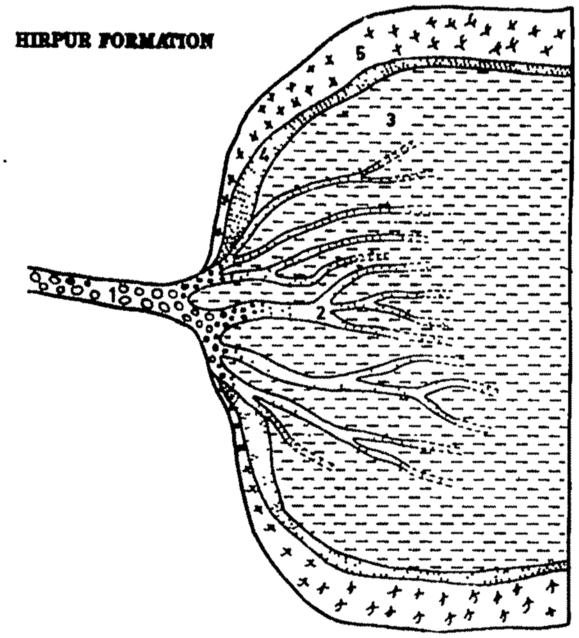


Fig.4. Schematic Plan View of Birdfoot Delta of Lower Karewa Times. 1 - River Channel Gravel, 2 - Subaqueous Distributaries, 3 - Lake Mud, 4 - Lake Beach, 5 - Lake Swamp.

1. Sequences related to the fluctuations in the sediment supply. It can be a coarsening-upward cycle like non-laminated mud rhythmites - sheet sand layers, or a finer upward cycle like cross-bedded sand - rhythmite - mottled mud.

2. Sequences related to the lateral migration of a Gilbert-type delta. Mostly lensoid sandbodies are formed showing low-angled inclined layers with wave ripple structures.

3. Major sequences related to main progradation of the shoreline related to changes in the lake size. For example, coarsening upward cycles or shoaling cycles (Fig.5),

During deposition of the Pampur Member the lake was restricted only to the NE half of the Kashmir valley. This lake was about 1-2 m deep, with a maximum depth around 10 m. Along the lake margins, a narrow belt of lake beach was present, made up of fine sand deposited by wave action. No marginal swamps were present. The muddy lake bottom was generally less than 2 m deep, almost always within the reach of waves, and supported extensive subaqueous vegetation. However, due to strong turbulence and oxidizing conditions

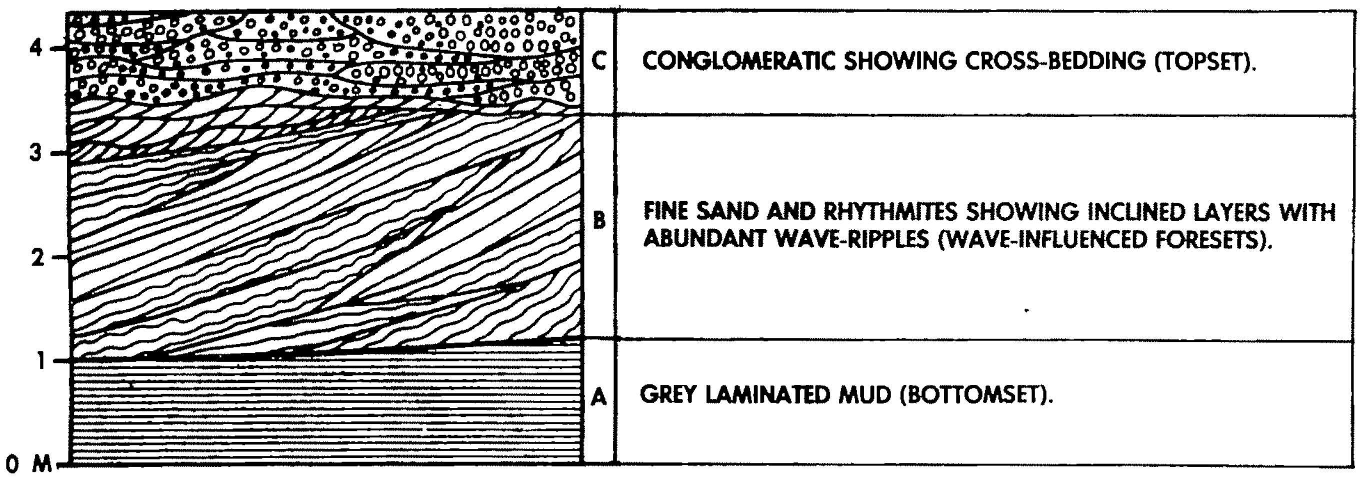

4
3
2
1
0 M
C
CONGLOMERATIC SHOWING CROSS-BEDDING (TOPSET).
B
FINE SAND AND RHYTHMITES SHOWING INCLINED LAYERS WITH ABUNDANT WAVE-RIPPLES (WAVE-INFLUENCED FORESETS).
A
GREY LAMINATED MUD (BOTTOMSET).

Fig.5. Idealized Vertical Sequence in Pampur Member (formed due to prograding Gilbert - type Delta. A - Lake Mud, B - Delta Front, C - Braided Stream.

organic matter is poorly preserved. Some precipitation of carbonate also took place. The rivers entering the lake produced wave-dominated Gilbert-type deltas (Fig.6). Due to the shallowness of the lake, the sand brought by the rivers was distributed by waves to produce sheet-sand bodies. In some areas lake deposits are seen laterally grading landwards into conglomerates of braided stream deposits. On the NE flank these conglomerates show calcrete deposits. The climate during the deposition of the Pampur Member was semi-arid, probably warm and not favourable for preservation of organic matter.

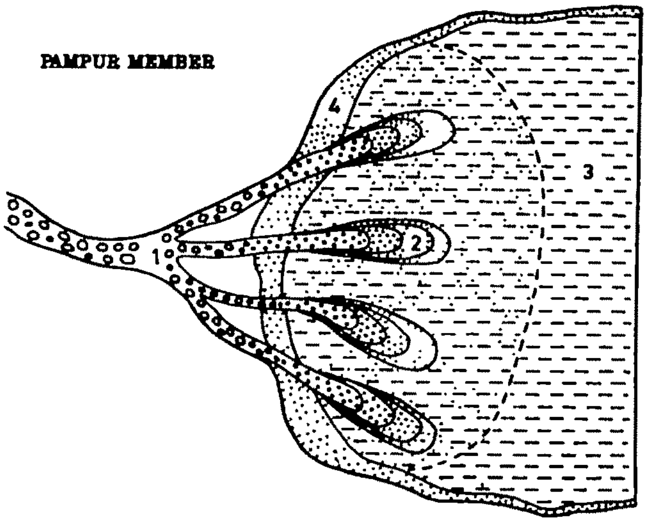


Fig.6. Schematic Plan View of Delta Lobes Formed as Gilbert Type Deltas of Upper Karewa Times. 1 - River Gravel, 2 - Delta Lobes, 3 - Lake Mud, 4 - Lake Beach.

Dilpur Member

There are very few sedimentological details available for this succession yet. This succession is variously termed as loam or loess (De Terra and Paterson, 1939; Bhatt, 1976). This unit shows a high variability in composition of sediment, grain size, etc. in different parts of the basin. It is mostly silty but contains horizons rich in sand or clay. Horizons rich in carbonate concretions are common, a few palaeosol horizons rich in organic matter are also present. Pant *et al.* (1985) and Bronger and Pant (1985) give details of the micromorphometry and variability in the loess succession of the Kashmir valley and emphasise its origin as an aeolian deposit (see also Pant *et al.* 1978). However, Tandon *et al.* (1982) consider this sequence to be deposited by wind activity punctuated with fluvial episodes.

As also discussed by Singh (1982), the Dilpur Member seems to be deposited mainly by sluggishly flowing streams, with important roles played by small ponds. Wind action was important, but the succession does not seem to be a dominantly wind-deposited loessic sediment. There are also several events of soil formation in the succession of the Dilpur Member.

Geological and Palaeoclimatic Implications of the Facies Analysis

The facies analysis of the Karewa Group brings out several points which have wider implications in interpretation of geology, age, and palaeoclimate.

The most important point which emerges is that the various lithofacies of the Karewa Group can be explained in a lake basin model. During deposition of the Hirpur Formation (Lower Karewa) a lake occupied the entire Kashmir valley, and the climate was rather humid, warm and supporting a warm - climate aquatic flora. The exposed sediments range in age from Pliocene to earliest Pleistocene. During the Early Pleistocene a major uplift in the Pir Panjal Range took place, which caused restriction of the lake basin only in the NE part of the valley. The uplift of the Pir Panjal Range was also

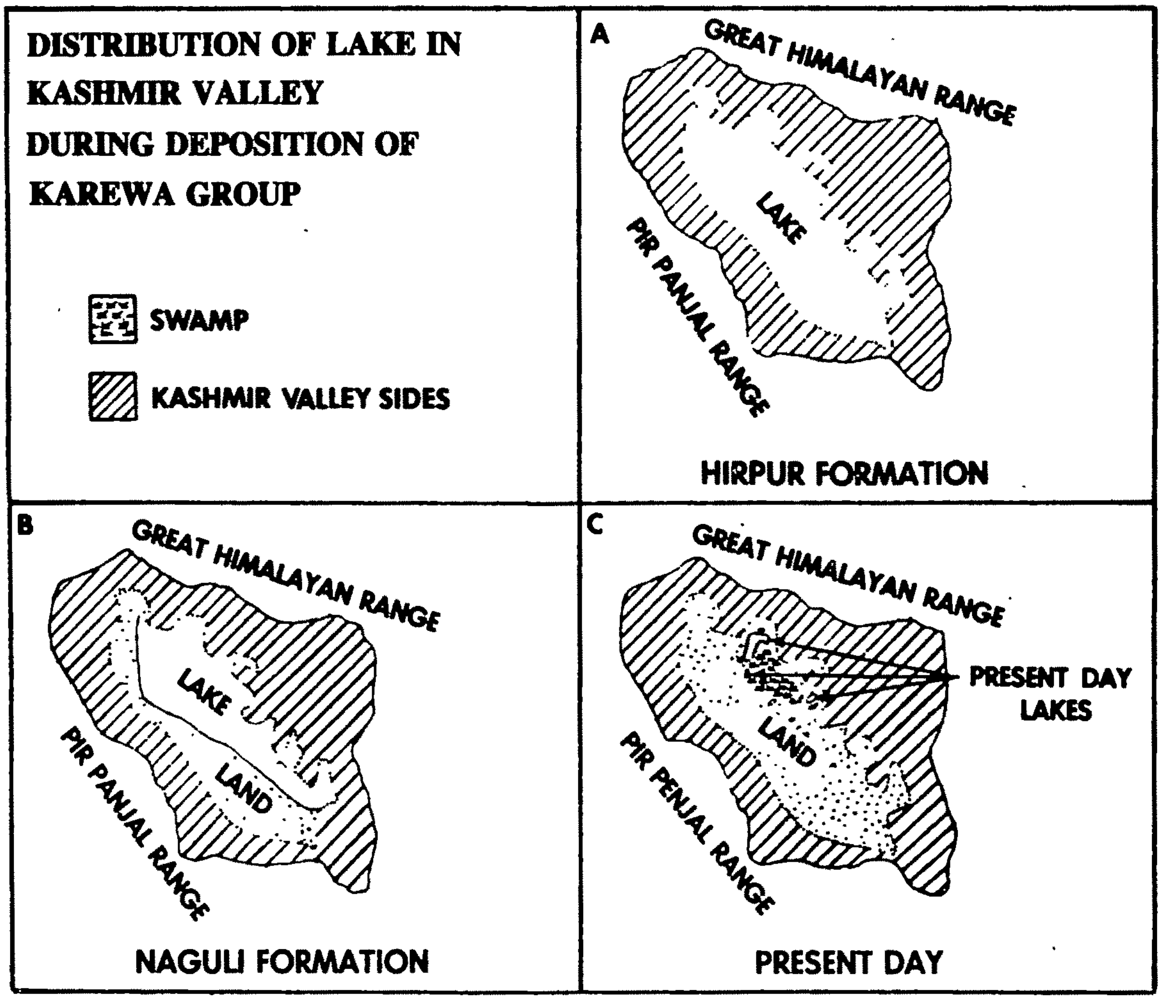


Fig. 7. Evolution of Lake Basin in Kashmir Valley During Deposition of Karewa Group (after Bhatt, 1982).

coupled with the rapid uplift of the Himalaya. Due to climatic change, the climate in the valley became rather arid during the deposition of the Pampur Member (Upper Karewa). The lake of the Pampur Member was also obliterated sometime during the Early Pleistocene, as a result of further uplift of the basin and Himalaya, and a breach in the mountains draining the lake waters (Fig.7). None of the lithologies of the Karewa sediments indicate deposition by glacial and related agencies. The loam sediments of the Dilpur Member represent deposition after the obliteration of the major lake system, and represent a long time span from the Middle Pleistocene to the Holocene (Singh, 1982). It is possible that in some parts of the SW flank, loam sediments started being deposited earlier than in the NE flank where a lake was still present. Recently TL - dating of the Dilpur Member in the Karapur section gives an age of 130 ka at 12 m below the top surface, while the total sequence is 24 m thick. (Singhvi *et al.* 1987) suggest that the loess sequence in Kashmir probably goes back to at least 300 ka.

Acknowledgements

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Radiometric Dating of a Quaternary Dune Section, Didwana, Rajasthan

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Introduction

Radiocarbon dating has proved to be a very reliable technique for determining the age of late Quaternary sediments. Dates older than 40,000 yrs B.P., however, are generally considered to be unreliable as the theoretical limit of this dating method is only about 60,000 yrs B.P. The recent application of the Uranium series dating technique for marine carbonates of Kutch and Saurashtra (Baskaran 1985) and thermoluminescent dating of aeolian sands from Rajasthan (Singhvi *et al* 1982) has provided a time frame for the Quaternary sedimentary sequences in northwestern India. In the following report we present the results of our attempts in applying the ^{14}C, U/Th and TL methods on pedogenic carbonates and quartz grains from the stabilised sand dune near Didwana, Rajasthan. Such an attempt has, hitherto, not been made.

Site

Didwana (27° 24’ N : 74° 35’ E) is a small town in the Nagaur district of Rajasthan (Fig.I). It is located on a plain dotted by stabilised, longitudinal and obstructed dunes. South of the town there is a salt lake, 7 km long and 2.5 km wide. A small cluster of low Aravalli hills lie 4 km southwest of Didwana town. These hills are quartzitic instrusions within the carbonaceous phyllites and schists. The area is characterised by a semi-arid climate.

Quaternary Deposits

The quaternary deposits of the area are represented by fluvial, lacustral and aeolian sediments. The Precambrian basement rocks lie 40 m below these sediments. They are classified into three major formations namely, Didwana, Amarpura and Jayal, which are based on the texture, colour, nature of disposition of the sediments, as well as on the archaeological material occurring within them (Misra *et al.* 1982, Raghavan 1987). The best exposure of the aeolian member of the Didwana formation is exposed in the profile of the 20 m trench excavated at 16 R locality in the Bangur canal near Didwana (Fig.II). On the basis of field observations (colour, texture, structure and abundance of calcitic nodules) this dune section has been divided into three major lithological units I, II and III.

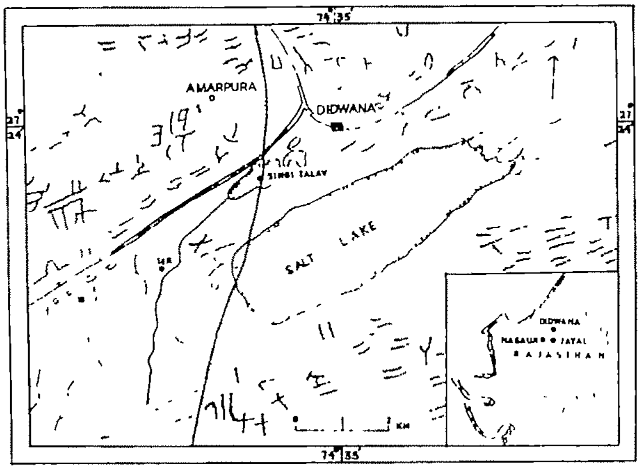

Fig.1.

Lithounit I which comprises 4.9 m is the upper layer and is composed of loose, structureless fine sands, which are light

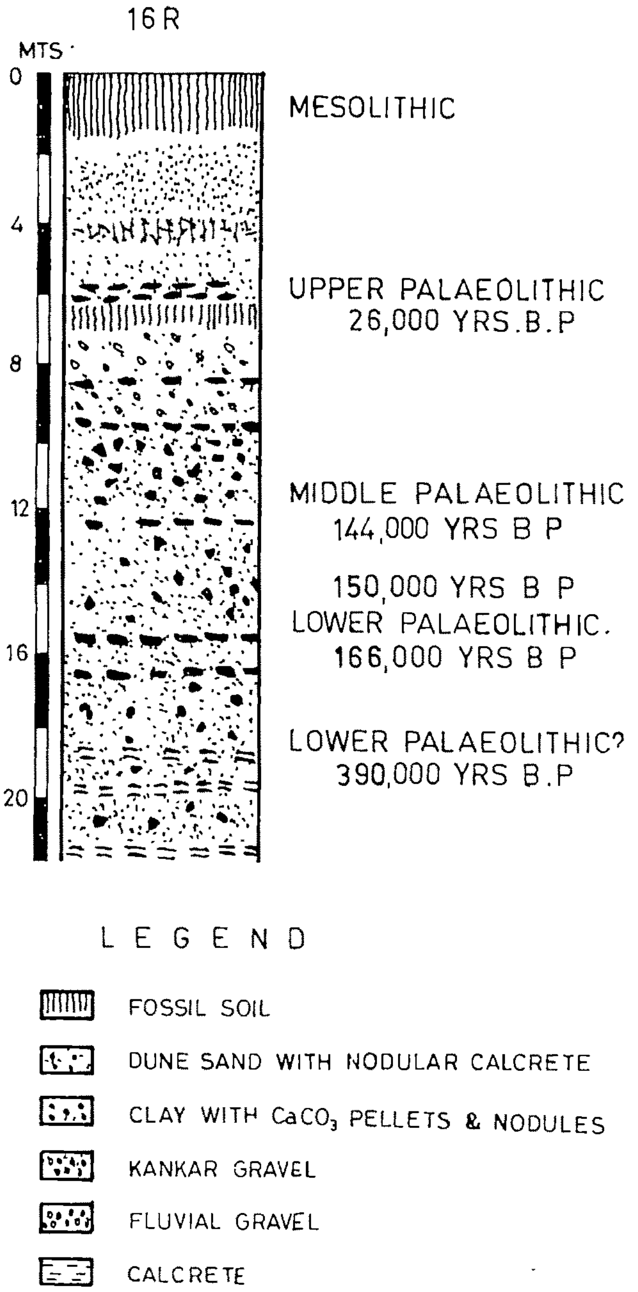

Fig.2.

yellowish brown (10 YR 6/4) and noncalcareous, and grade to pale brown (10 YR 7/3) with a few, small, powdery calcitic nodules. A few channels and remanants of small roots were observed. The sands are clearly separated from lithounit II by a 10 cm thick layer of lightish grey (10 YR 7/2) coarse sands, including fine layers of rounded schist fragments. This layer represents a colluvial wash.

The following 3.05 m (lithounit II) comprises alternating layers of densely coalesced calcite nodules within light grey (10 YR 7/2), loose, well sorted and calcareous fine sands. These form bands which are a few cms thick, composed of moderately sorted loamy sands, of a light yellowish brown (10 YR 6/4) to pale brown (10 YR 7/3) colour. The loamy sands have a low content of calcium carbonate but contain well cemented to powdery, amoeboidal, sparsely distributed calcitic nodules.

Lithounit III of 10.95 m thick differs from lithounit II both in colour (7.5 YR 7/4) and because of the presence of large calcite nodules. Eleven calcrete bands were identified within this unit. The calcrete band at 18.60 m depth is highly indurated and classified as a petrocalcic band. Field observations reveal that the top 80 cm of lithounit I is a cambic horizon and the 3.50 m of lithounit II is a complex BCa horizon. Lithounit III is largely affected by a calciorthid type of pedological process. The occurrence in units II and III of colluvial wash in the form of locally derived schist and slate fragments, as well as the presence of calcrete clasts suggest that the entire profile is the result of aeolian activity modified by local fluvial processes. It may also be noted that all the three lithological units of the 16 R dune section are exposed in Ram Lal's well, 1 km northeast of 16 R, and at several other places in Nagaur district.

Prehistoric Tools

Palaeolithic tools have been recovered from different levels within this dune section. Mesolithic artifacts have been found on the surface of lithounit I. Upper Palaeolithic tools were recovered from lithounit II between 5.00 m and 6.00 m. Middle Palaeolithic artifacts were randomly distributed between 9.00 m and 13.00 m and a few lower Palaeolithic artifacts were found to occur at 17.20 m and 18.40 m in lithounit III.

Results and Discussions

The presence of archaeological material in a semiprimary context within the dune section helps to establish a relative chronology for the site. However, the application of more precise dating methods, such as radiocarbon, TL and U/Th series, were considered more valuable in determining the rate of dune building activity and palaeosol development.

Soil samples were accordingly collected and the radiocarbon dates on pedogenic carbonates from the Upper Palaeolithic level were processed at the Physical Research Laboratory, Ahmedabad. The age result is 26, 210 $\pm^{2200}_{1700}$ yrs B. P. (PRL No.911).

TL dates for quartz grains from a depth of 17-18 m were processed at Thermoluminescene, Alpha Lab. U.S.A. The age result for the coarse fraction is 1,63,000 ±21,000 yrs B. P. whereas the date for the fine fraction ranges between 1,08,000 and 1,44,000 (Alpha Lab. No.963) (Misra *et al.* 1987).

The application of the U/Th series method was attempted by the first author at the Physical Research Laboratory, Ahmed-

Table -I.

Sr. No.	Depth in m.	Weight in gms	Insuluble. residue in gms	Weight of leach in gms	FR/FL	$^{238}U_L$ dpm/gm	$^{230}Th_L$ dpm/gm	$^{234}U_L/^{238}U_L$	$^{230}Th/^{234}U$	Uncorrected age
1.	12.65	20	7.65	12.34	0.60	0.39 +0.013	0.347 +0.01	1.208 +0.040	0.732	1,44,000 ±12,000
2.	14.25	20	9.72	10.28	0.94	0.34 +0.009	0.316 +0.01	1.237 +0.031	0.750	1,50,000 +10,000
3.	18.60	20	8.10	11.89	0.68	0.362 +0.01	0.453 +0.01	1.210 ±0.033	1.035	3,90,000

The dates represent a minimum age.
The date of 3,90,000 + 50,000 on petrocalcic hardpan calcrete reaches the limit of U/Th dated method and hence there is an uncertainty in accepting this number.

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abad. Only three samples of pedogenic carbonates from distinct stratigraphic horizons were analysed. The samples were selected from the depth of 12.65 m., 14.25 m and 18.60 m. Standard radiochemical procedures for the separation and purification of uranium and thorium were carried out following the methods of Ku *et al.*(1979).

All the analytical data on the leachate fractions of the sample are listed in Table I. Values for the carbonate contents are approximate as they are estimated from the acid insoluble weights. They are presented here to indicate the amount of impurities encountered in the samples analysed. Purified uranium and thorium were plated on a 2.5 cm diameter platinum disc, to give thin sources for alpha spectrometry. These thin sources were counted for an average period of 4 days in a Multichannel Analyser Mark IV made by Electronic Laboratory, Physical Research Laboratory, Ahmedabad, with a silicon charged particle radiation detector ORTEC Model No. TB - 25 - 450 - 200.

The isotopic composition was then determined by the alpha particle energy spectrum (graphs of the background counts, standard uranium and thorium counts).

The age 't' of the sample was computed using the formula :

$$^{230}\mathrm{Th} = {}^{238}\mathrm{U}\,[1-\exp(-\lambda_{230}t) + ({}^{234}\mathrm{U} - {}^{238}\mathrm{U})]$$
$$[\lambda_{230}/(\lambda_{230}-\lambda_{234})]\quad[1-\exp(\lambda_{234}t-\lambda_{230}t)]$$

Where λ_{230} = decay constant of ^{230}Th

λ_{234} = decay constant of ^{234}U

The calculated uncorrected ages are given in Table I. These ages are uncorrected because the uranium and thorium in the residue fractions have not been measured. Nevertheless, the dates are consistent with the stratigraphy, archaeological material and the dates obtained by TL and ^{14}C methods.

The lithostratigraphy and the archaeological finds, together with the few radiometric dates indicate that dune building activity began more than 2,00,000 yrs ago and continued with interruptions almost throughout the Late Pleistocene. On the basis of field data and available absolute dates, the Lower Palaeolithic material located in a dune palaeosol context in the 16 R section can also be assigned to the Late Middle Pleistocene.

Conclusions

These radiometric dates indicate that the aeolian processes on the eastern margin of the Thar desert are at least 2,00,000 yrs old. That these processes were at times relatively weak is indicated by the presence of calcretised palaeosols ranging in age from about 1,00,000 yrs B.P. to about 60,000 yrs B.P.

This process of dune building activity suggests that the climate since the late Middle Pleistocene fluctuated from semi-arid to arid and vice versa in this part of the Thar desert. However, the data need to be substantiated by further research on the subject.

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Geomorphic Evaluation of Some Longitudinal Stream Profiles : Implications on Landscape Stability in Western Upland - Maharashtra (India)

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Introduction

The characteristics of runoff and sediment yield are principal determinants of the physical properties of the geomorphic landscape. The magnitude and frequency, of water and sediment yield are primarily governed by the climatic and the tectonic status of an area. Not surprisingly, many interpretations and inferences contradict each other. In Western Upland Maharashtra nearly all the landforms were attributed to these two geomorphic parameters. Rajaguru (1970), Corvinus *et al.* (1973), Powar and Patil (1980), Qureshy (1981), Corvinus (1981), Jog and Karlekar (1982), Powar and Kale (1985) and others for example, postulate that the landforms and the drainage are adjusted to tectonic and/or cymatogenic movements. Dikshit (1970), Rajaguru (1973), Kale (1983), Rajaguru and Kale (1985) and others, however, hypothesized that the valley and channel forms have evolved and developed in response to present and past climates. Both the hypotheses are supported by field studies. The prevalence of one mode of hydraulic response over another apparently depends upon the prevailing geo-environmental characteristics of the drainage system and upon the relationship among existing and antecedent geomorphic events.

Although the geomorphic features in some localities of the Upland suggest the possibility of tectonic movements, there are very few geological evidences in the field to support this hypothesis. Karmarkar *et al.* (1985) are of the opinion that there are no tectonic features in Western Maharashtra and no tectonic movements have taken place in the area. As against this, Powar and Kale (1985) have indicated, on the basis of recent photogeological, geophysical and seismological data, that some of the geomorphic features in the Upland are clear manifestations of cymatogenic movements in the geological past.

In the present account it is proposed to identify the features that characterize the landscape and then to verify the two hypotheses by employing the longitudinal profiles of thirteen higher and middle order streams from Upland Maharashtra (Fig.1). The long profiles of natural streams are the least transient expression of fluvial processes, reflecting the effect of the present and antecedent geomorphic processes. Hence they are an appropriate indicator of morphogenetic and tectonic history on a broader temporal and spatial scale.

The Longitudinal Stream Profile

The long profile can be expressed as the relations between the fall or the vertical distance below the source and the length, or horizontal distance from the source (Hack 1957, Leopold *et al.* 1964, Morisawa 1985). Most of the river profiles expressing this relation have a parabola like shape, steep near the source and gradually flattening as the distance from source increases. The long profile is composed of segments, each of which is exponential or nearly so (Tanner 1971). Each segment tends to plot on semilog paper (distance vs log elevation) as a straight line with a faint upward convexity near the source and a faint downward concavity near the lower end of the segment (Leopold *et al.* 1964, Tanner 1971).

The inverse relationship between channel gradient and river discharge, recognized by many workers explains the concavity of the long profile of natural streams. Flume experi-

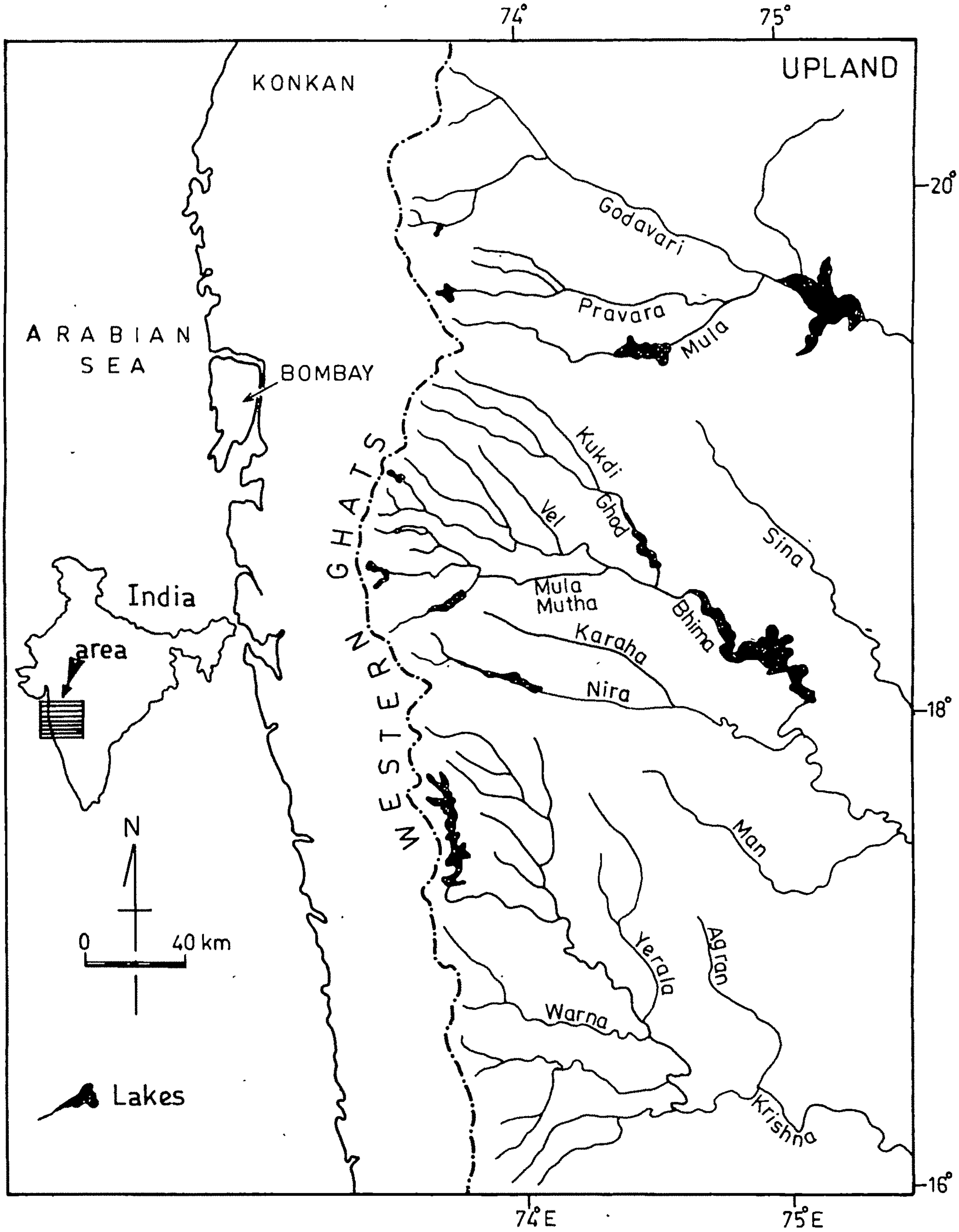

Fig. 1: Map of Western Maharashtra Showing the Location of Rivers Described in the Text.

ments and studies in the field have established these interrelationships (Schumm 1977, Richard 1982).

Mathematical Expression of the Long Profiles

Since the 19th Century it has been accepted that the river profile tends to be concave upward and theoretically approaches a height of zero at the base-level. The general concavity of river profiles plotted in the Cartesian Co-ordinates of 'height, H' and 'distance from source, D' may be described by a range of mathematical functions. The tendency for distribution of height (H) as a dependent variable to vary with distance (D) as an independent variable has warranted attempts to describe the longitudinal profile by equations. Three equations may be identified for establishing the height-distance relations.

i) $H = C - K \log D$ (logarithmic form)
ii) $\log H = C - KD$ (exponential form)
iii) $\log H = C - K \log D$ (power form)

Although the above models are applicable to rivers in different situations, the last equation (power form) is found to give a good approximation of the river profiles of the rivers of Upland Maharashtra. The power form has been employed here, because the prime objective of this exercise is to compare and contrast the 'b' coefficients (i.e. rate of change) of the various rivers in order to evaluate the stage of river development. This is possible when the equations are best fit and the explained variance is high. In the case of the Upland rivers, analysis shows that the power form gives a better fit than the exponential form. Thus, the earlier form has been employed for profile evaluation. The equations obtained by integrating an appropriate height - distance relationship are tabulated in Table 1. Large values of the base constant 'c' (in $\log H = C - K \log D$), indicate a higher altitude near the source and small values suggest lower elevation near the source. Similarly, the regression coefficient (k) reflects the nature and type of curvature. Negative values of the coefficient reveal a concave profile and large negative values imply a rapid change in height with distance and a pronounced concavity. Figs. 2 and 3 depicting the estimated curves, illustrate that comparatively the Venna, Koyna, Mula (Nagar), Pravara and Krishna rivers are marked by high negative coefficient values and can be referred to as "high-concave" streams. On the other hand, rivers like the Indrayani, Kukdi, Mula, Mutha and Godavari have low negative coefficients and can be termed as " low-concave" streams. The values further suggest that in the case of "high concave" rivers the downstream increase in discharge and perhaps the sediment load is very rapid. The "low-concave" streams, on the other hand, do not seem to be experiencing such a rapid increase.

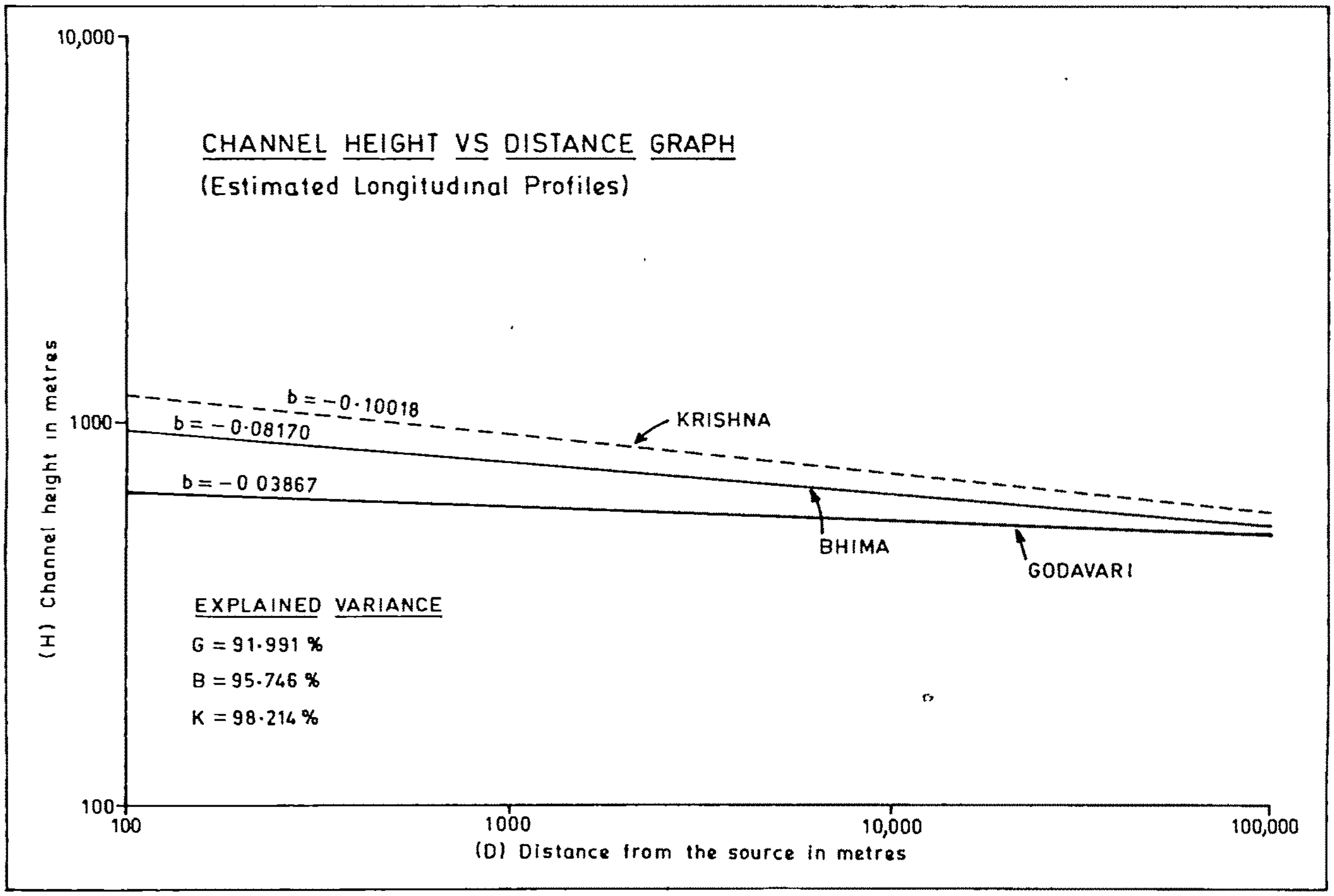

Fig.2: Graph Showing the Estimated Longitudinal Profiles of Three Higher Order Streams.

In other words, the equation and the correlations (Table I) denote that the height decreases in a regular manner as discharge increases, because discharge and the longitudinal profiles are related and interdependent.

Factors Determining the Gradient of the Stream Channel

Although implied in the previous discussion, thus for no explicit mention has been made of adjustments in gradient in natural channels. Gradient has been primary concern of the geologist and geomorphologist inasmuch as it is the stream profile which is most markedly revealed in the landscape. Through understanding of the factors related to the long profile and stream gradient some idea of previous climate and tectonics may be reconstructed using geomorphic evidences, of which channel slope, is an important element.

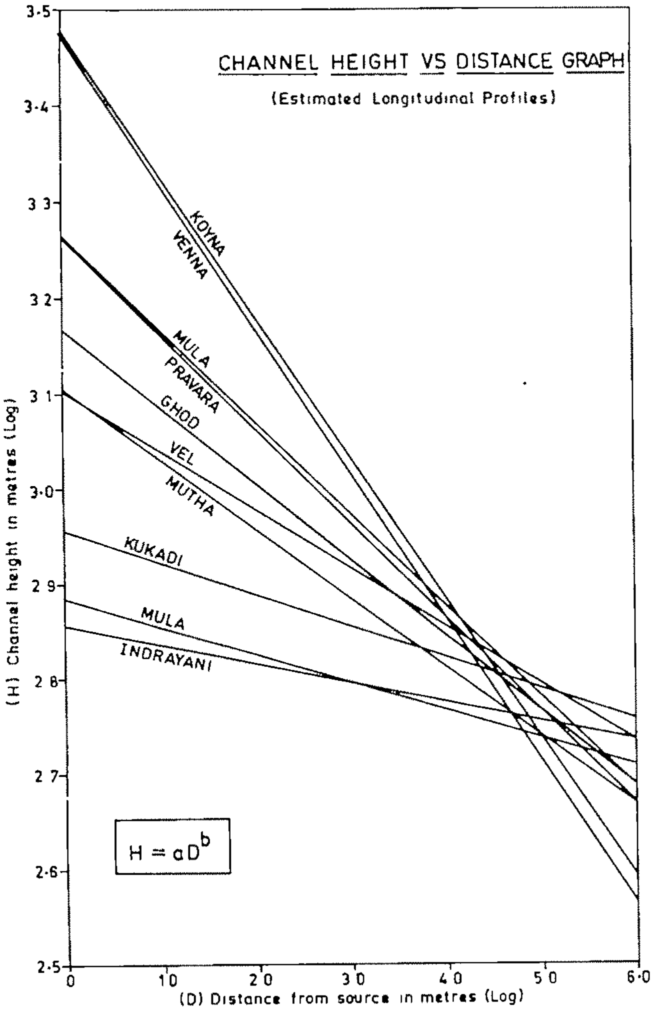

Fig.3: Graph Showing the Estimated Longitudinal Profiles of Ten Middle Order Streams.

The gradient as used herein is the average slope of the longitudinal profile of the stream channel expressed in percentage. The gradient of the river is determined and controlled by various morphological factors like relief, discharge, catchment area, etc. The data presented in this report permit as appraisal of some of the controlling factors.

Catchment Area, Discharge and Channel Gradient

The quantity of water or discharge is one of the important factors controlling channel slopes. In practice, the relationship cannot be measured because there are very few gauging stations that have been in operation for long enough in the study area. Nevertheless, a conservative relation exists between the catchment area and discharge, that is, enlargement of drainage area is accompanied by a corresponding or a proportional increase in discharge. The logarithmic graph in which the average discharge for the various stations of Upland, is plotted against drainage area, shows that there are inter-basin differences, in spite of a conservative relationship (Fig.4). Whereas in the Krishna basin the regression coefficient value (b) is high, in the Godavari basin it is low. The coefficients suggests that in the Krishna basin, followed by the Bhima, the rate of change in discharge is very rapid with an increase in the catchment area. This rate, however, is less in the Godavari basin. It must be clearly stated here that the relations holds good only for average annual discharge, and there are bound to be some departures from the conservative relation in lower order streams and rivers. Nonetheless, the significance of these qualifications is that one may substitute catchment area for discharge (Hack 1957, Leopold *et al.* 1964).

Catchment area has been plotted against channel slopes for the rivers of the study area (Fig.5). The figure displays that in a general way the river slope decreases as the catchment area increases. The scatter of points in the figure connotes that there are other basin morphological factors that control the values of stream slopes.

The relation of basin circularity to channel slopes, or, the rate at which drainage area is added in the downstream direction is also an important factor affecting the longitudinal profiles. Another way of stating the relation is to say that for a given basin, the channel gradient at any point is approximately determined by drainage area and the available runoff. Thus, streams with circular basins, will add more basin area (as well as runoff) in a downstream direction, than elongated basins. This may be expressed, for the study area, by the equation :–

$\emptyset_c = 0.8542 - 1.0872\ Bc\ (r = -0.5384)$

Where O_c = channel slope in percentage.

B_c = Basin circularity in percentage.

Sr.No.	Rivers	Base Constant in metres (c)	Regression Coefficient (k)	Correlation	Explained Variances (%)
1.	Godavari	785.84	-0.0387	-0.9591	91.98
2.	Pravara	1653.01	-0.0969	-0.9802	96.08
3.	Mula(Nagar)	1839.70	-0.0995	-0.9464	89.56
4.	Ghod	1458.85	-0.0799	-0.9516	90.55
5.	Kukadi	901.35	-0.0332	-0.8502	72.28
6.	Vel	1262.99	-0.0625	-0.8129	66.08
7.	Bhima	1382.64	-0.0817	-0.9785	95.75
8.	Mutha	1285.36	-0.0746	-0.9686	93.82
9.	Mula	765.11	-0.0294	-0.9475	89.77
10.	Indrayani	719.82	-0.0203	-0.9499	90.23
11.	Krishna	1861.74	-0.10018	-0.9910	98.21
12.	Venna	2989.31	-0.1524	-0.9710	94.28
13.	Koyna	3017.2	-0.1483	-0.9177	84.22

Table - I: Parameters obtained by regression analysis, showing base constant, coefficient and correlation values.

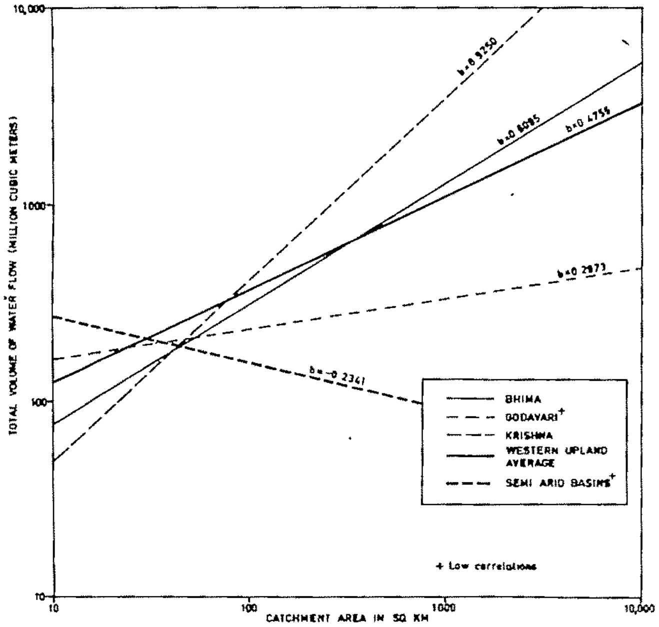

Fig.4: Logarithmic Graph Showing the Relations Between Catchment Area and Discharge in Western Upland Maharashtra. Data Source: Irrigation Department, Maharashtra

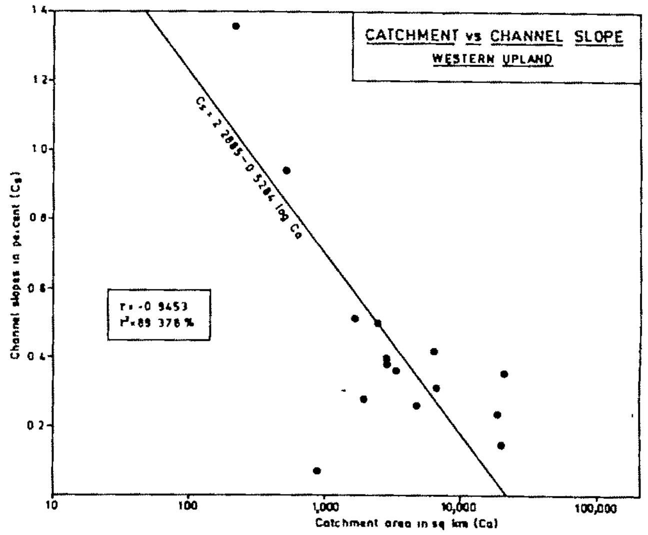

Fig.5: Scatter Diagram Showing the Relations between Catchment Area and Channel Slopes.

Although, the scatter of points is large the correlation suggests that in a general way channel slope decreases as basin circularity increases. The intercorrelation indirectly also supports the inference, mentioned earlier, that the channel gradient is governed by the available catchment area or discharge in the downstream direction.

Basin Relief and Channel Slopes

The topographical features of the basin have an influence on the channel characteristics of the Upland rivers. This is because the stream must carry away the erosion products of the entire basin. If the relief (absolute and relative) is high, it determines the minimum threshold channel slope required to carry off the erosion products and hence affect the rate of channel grade conditions. Since the master stream acts as a local base-level for its tributaries, it affects their gradients and therefore the topographic forms of the adjoining areas.

This suggests that, since channel slopes and relief are interrelated in a regular manner, a plot of gradient against absolute and relative relief should result in a grouping of points. Since the two relationships are grouped closely about straight lines, the relation between channel slope ($\varnothing_c$)and relative relief (Rr) and channel slope and absolute relief (Ar) may be expressed as power function :-

$$\varnothing_c = 0.0074\,Rr^{0.62003}\ (r = 0.6479)$$

$$\text{and } \varnothing_c = 1.1369\,Ar^{1.8072}\ (r = 0.6282)$$

The equations connote that the channel gradient increases more rapidly on an average, proportional to 1.8072 power of its absolute relief than its relative relief (b 0.62). The association suggests that in a general way the decrease in basin relief is accompanied by corresponding decrease in channel gradient.

Stream Length and Channel Slopes

The relation of length (L) to channel gradient ($\varnothing_c$),or the rate at which length changes, is an important association governing the longitudinal profiles. If relief is same, slope is related to stream length. It is apparent that the channel slope might decrease because of either a decrease in the fall between two points or an increase in the stream length, as for example, by the development of meanders (Hack 1957). In order to evaluate the relation for the Upland rivers, regression analysis was carried out. The analysis reveals that the values are grouped closely about a line expressed by the equation :

$$\varnothing_c = 2.0979 - 0.7589 \log L$$
$$(r = 0.6242)$$

The logarithmic form, suggests that for a given basin, the channel slopes is approximately determined by the stream length on the channel pattern.

The Channel Gradients and Valley Slopes

In normal valleys which widen downstream, the channel gradients are less than or equal to valley gradients (Richard 1982). A conservative relation exists between the geomorphic parameters; that is the change in the channel slopes is associated with a proportional change in the valley slope(longitudinal). This is shown by the scatter diagram (Fig.6), in which the average channel gradient($\varnothing_c$) is plotted against the longitudinal valley gradient ($\varnothing_v$) The paired values are grouped closely about a line expressed by the equation :-

$$\varnothing_c = 0.0065 + 0.7692\,\varnothing_v\ (r = 0.9921)$$

The arithmetic relation reveals that within narrow limits the channel slopes increase with a corresponding increase in valley gradient. It must be kept in mind that the relation holds good only for average gradient and there are deviations from this conservative relation, especially in lower order streams.

The average channel gradient values in all the basins are marginally less than the valley gradients. This can be attributed to near normal grade conditions of the rivers of the Upland. The differences in the values also indicate that the rivers are not deeply entrenched. However, comparatively the difference between the two parameters is high in the case of the Venna (0.30), Koyna (0.19), Mula (Nagar) (0.16), Pravara (0.13), Vel (0.25) and Karha (0.14) rivers. These differences are also manifest in the form of gorges in the upper segments of the first four rivers.

The last two rivers are plateau rivers occupying inter-basin divides and thus belong to a younger generation of the Upland drainage system (Jog 1985, Kale and Rajaguru - in press).

The Longitudinal Profiles and the Cycle of Erosion :

The longitudinal profiles express in the geomorphic history and the stage of drainage development in the most sum-

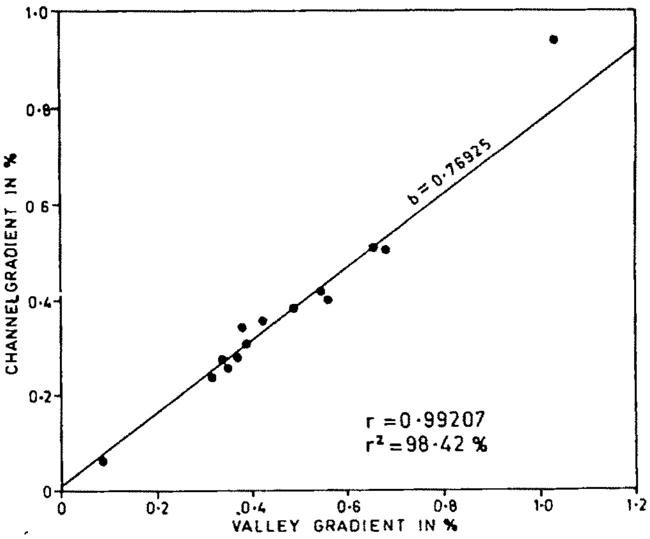

Fig.6: Scattergram Showing the Relations between Longitudinal Valley Slopes and Channel Slopes for the Rivers of Up-land.

marised form. The drainage evolution through time can be comprehended by the analysis and classification of the long profiles. The base constants and the regression coefficients are the best indicators of the nature and stage of drainage development. Hence the regional base constant $(\bar{c})$ and the regional regression coefficient $(\bar{k})$ has been employed herein to classify the profiles. Rivers which lie above or below the regional mean have been isolated. Similarly, rivers which have base constants above the regional mean but coefficients below the regional mean and vice versa, have been identified and grouped. Such a classification is statistically sound and at the same time very simple. The groups accordingly identified, are given in Table II.

The first group of rivers includes five rivers which have a high rate of change downstream as well as a higher elevation in the source region. Comparatively the channel gradients are steeper (0.38 to 1.66%). The variance explained by the equations computed for the profile data is above 94%, except for the river Mula (Nagar), which records 89.56%. The rivers are associated with youthful drainage characteristics. Rivers like the Mula (Nagar), Pravara and Venna have major knick points and gorges and reflect juvenile features.

The second group of rivers does not include any of the sample rivers.

The third group of rivers consists of the Bhima and Ghod. The profiles have an explained variance of 95.75% and 90.55% respectively. These two rivers are higher order streams and reflect relatively more mature characteristics. There are no spectacular inflection points in the river profiles and the basin landforms also reveal mature features. The channel slope of the Ghod and Bhima are respectively 0.26% and 0.27%.

The fourth group includes six rivers with very distinct mature channel and topographic forms and features, except the river Vel. Rivers like the Indrayani, Kukdi and Godavari are associated with major gaps in the Western Ghats. The broad and open valleys right in the source region coupled with low channel gradients suggest a well advanced stage of drainage and channel development. Though rivers like the Godavari (Gangapur, Chas, Nandur-Madmeshwar), Indrayani (Shelarwadi) and Kukdi (Nighoj) have major knick points, they have been grouped in the mature category, because the average gradient of these rivers is very low (0.07 to 0.24%) and their elevation in the source region is much less than of other rivers.

River Vel which has been included in this group because of lower c and k values, however, does not belong to this class. The river is a plateau top river and has a higher channel slope (0.94%). Thus, it is misfit and has to be considered separately.

The Stability of the Landscape

It has been shown that several basin and drainage factors are important in controlling the longitudinal profiles of the Upland rivers. Of principal interest to geomorphologists is the inference that within the study area, where the bedrock geology is the same, there is a consistent relation between channel slopes and other factors like relief, catchment area (discharge), stream length, valley gradient and basin circu-

Sr.No.	Regression	Parametres	Rivers	Stage of Drainage Development
	c = 1532.53	k = -0.9782		
1.	above c	below k	Mula (Nagar), Pravara, Krishna Koyna and Venna	Juvenile Youth stage
2.	above c	above k	--	--
3.	below c	below k	Bhima and Ghod	Late Youth - early maturity stage
4.	below c	above k	Godavari, Kukadi, Indrayani, Mula, Mutha and Vel	Maturity - Late maturity stage

Table - II: Classification of the sample rivers on the basis of regional C (mean) and K (mean).

larity; and the differences are related to evolutionary history and to the stage of the drainage development. The topographic forms and valley characteristics in the field also exhibit these relationships. Rivers like Godavari, Kukdi and Indrayani are mature rivers, with gentle slopes in the headwaters diminishing gradually downstream. Other rivers especially, Koyna, Venna, Pravara and Mula (Nagar) have relatively steeper gradients in the upper reaches, diminishing rapidly downstream.

The relation between channel slopes and the relief parameters and the valley gradients suggests that the supply of the erosional product has determined the longitudinal profiles of the rivers. Another way of stating this is to say that due to high basin relief and steeper hillslopes the supply of sediments as well as runoff is high and therefore in order to carry this the 'High-concave' rivers have to maintain a steeper gradient. Similarly , in the case of broad and open valleys the supply of water and sediments to the rivers is reduced and the 'Low-concave' rivers maintain a minimum channel slope.

The principal interest to geomorphologists is that such a relationship reflects a long-term stability of the geomorphic landscape in this part of the Trappean terrain in morphological development, with minor recent channel pattern adjustments. Since the geomorphic processes are not very swift and drainage systems respond very slowly to environmental changes, the conservative relations (between channel gradient and other basin characteristics) imply that during the recent geological past, no major disturbance or catastrophe in the form of tectonic movements, has interrupted the Neogene Geomorphic Cycle. The association between the topographic parameters and the channel slopes further denotes, that the balance between the two has remained undisturbed and the landscape has experienced tectonic stability for a large part of the late Neogene period. Quaternary studies in the review area have revealed that in the past 50,000 years or so there have been some changes in the bed-elevation and channel gradient, in response to alterations in the river transportation capacity (Rajaguru and Kale 1985). Nevertheless, in view of the extent and magnitude of these changes it can be inferred that these fluctuations in the fluvial regime were marginal and thus have not substantially affected the river equilibrium.

Overview and Inferences

Geologic constraints are basically of two types-lithology and structure. In the upland region, owing to uniformity in rock type, lithology appears to have exerted little influence on river morphology and network topology. The possible role of structure is difficult to evaluate because in many cases, erosion has removed or obscured the evidences. Structural controls may be passive (former tectonic activity) or dynamic (active tectonism) (Morisawa 1985). The dynamic controls are more obvious in determining the river erosion and the nature of the river profile. The long term morphologic effects of active tectonism depend on inequality or river processes. The active tectonic movements need to be greater than erosion rates of rivers if they are to have a significant long term visible influence on stream profile. When tectonic movements increase the potential energy of rivers, the river is rejuvenated, the rate of erosion is increased and the river will begin incise. However, the Upland rivers reveal very few evidences to support this observation. The difference in the valley gradient and channel gradient is marginal (0.07% to 0.38%) and the rivers do not reflect deep incision in bedrock Similarly, there are not many evidences to suggest the possibility of vigorous channel erosion and high overall erosion in this region. Knickpoints, gorges and aggradational features as an expression of tectonic movements fail to provide any information in this respect. Further, as the higher order streams like the Bhima and Krishna do not exhibit a noticeable inflection point, the probability of dynamic structural control on the river profiles is small. Moreover, the hypothesis of dynamic control falls for want of any concrete evidences including any visible fault or deformation. In such circumstances one is inclined to ascribe the present nature of the Upland rivers to the "inequality in river energy". The model attempts to explain the difference in the long profile (nature and gradient) of the streams, in terms of the available potential and kinetic energy. According to this hypothesis the available energy depends on the elevation and the length traversed (Morisawa 1985). If two rivers have different elevation from the same area, the rivers with high elevation will have greater potential energy. Similarly, the available kinetic energy for work depends inversely on the length traversed. The greater the length of the stream, the greater the loss of kinetic energy. The Upland rivers appear to be a good example of such unequal forces at work. With the exception of a few differences the conservative relations between channel slope and the geomorphic parameters (like, relief, catchment area and discharge, valley slopes etc.) implicate that the long profiles of the Upland rivers are the result of the available potential and kinetic energy and there seems no need to invoke tectonism as a cause of river erosion and profile development. The departures from the known conservative relations in the case of some fluvial systems is perhaps related to intrinsic geomorphic thresholds, peculiar to each basin (Schumm 1977).

Geostatistical analysis of the long profiles demonstrate that rivers like the Pravara, Kukdi, Venna and Indrayani with noticeable knicks have graded stretches similar to other rivers. The interruption and rejuvenation of these rivers appears more logically to have been caused by the differences in the grade conditions of the parent and tributary streams. The differences in the grade levels of the parent stream, proves adequate to make its impact felt on the tributary stream. The deduction seems plausible, in the absence of any tectonic features in the vicinity of the knicks. It appears more logical to assume that the inflection points merely convey different stages or levels of river grading.

Nevertheless, in spite of the inferences about the atectonic nature of landscape, the possible role of tectonic movements cannot be ruled out completely. Therefore, there is urgent need to locate and identify more evidences to understand the existing anomalous geomorphic situations and the mode of landscape evaluation in upland Maharashtra.

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Heavy Mineral Distribution in the Fluvial Micro-Environments of the Upper Sarju River, Kumaon Himalaya

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Introduction

The Upper Sarju River is an important Himalayan river. Originating from north of Jhuni, a snow fed area, it drains the Central Himalayan range. The general flow direction of the river between Jhuni and Bageshwar is south westerly with numerous north-south bends. Several tributaries join it from various directions.

Little work has been done on the distribution of heavy minerals in the fluvial environment of the Kumaon Himalaya. The present paper is a preliminary attempt by the authors towards such studies in the Kumaon Himalaya. They have collected representative samples from various locations and successive horizons of the Quaternary fluvial sequence. They have followed the techniques adopted by Riezebos (1979) and Chaudhri and Gill (1984).

In an earlier paper, Chamyal (1987) has described the Quaternary deposits of the Upper Sarju Basin and a more detailed account by Chamyal and Pant is in preparation. According to Chamyal (1987) the Quaternary sediments constitute three well developed terraces and are exposed in various cliff sections along the Upper Sarju River. The terraced deposits are generally semi-consolidated but occasionally fine stratifications are observed by the author. The cliff sections are Dulam and Munar show a well developed Quaternary succession. He has further stated that at present glacial moraines are found only above 2000 m altitude. In the past, however, at lower altitudes too, the presence of glaciation is typically reflected in the stratigraphic sequences, a good example being at Dulam. Chamyal has suggested two glacial and three interglacial sequences in the Upper Sarju basin. Chamyal and Pant (in preparation) have been able to recognise two major Quaternary formations in the basin (1) Dulam Formation and (2) Mandalsera Formation. The Dulam Formation constitutes a basal fanglomeratic deposit overlain by a sand facies. This sand facies is replaced by a series of rythmites. The varvites which appear next in the succession are the most interesting member of the Dulam Formation. The Dulam Fanglomerate appears to be a glacial out-wash whereas the rythmite and varvites represent a lacustrine facies (Chamyal and Pant, in preparation). The Mandalsera Formation lies unconformably over the Dulam Formation and consists of allostratigraphical terrace units. A total number of 6 terraces (T_o – T_5) were recognised above the modern channel of the river Sarju at Bageshwar. T_o is a well developed terrace with a deeply weathered red soil profile on top. All other terraces show weakly developed soil cover in contrast to T_o (Chamyal and Pant, in preparation).

Geologically, the Upper Sarju Basin falls into four major litho-tectonic zones (Fig. 1). The northern-most central crystallines comprising schists, gneisses, quartzites and amphibolites are separated from the rocks of Krol Belt metasedimentaries by the Main Central Thrust (Heim and Gansser, 1939; Gansser, 1964; Chamyal *et al.* 1985). The rocks lying immediately below M.C.T. comprising quartzites, graywackes chlorite schists are known as the Loharkhet Formation (Misra and Bhattacharya, 1972; Chamyal and Merh, 1985) and form the youngest rocks of the valley. The base of this formation marks an unconformity and is underlain by the metasediments of the Chandpur and Deoban Formations. The latter sediments are designated as the Kapkot Formation. They consist of dolomitic limestones and

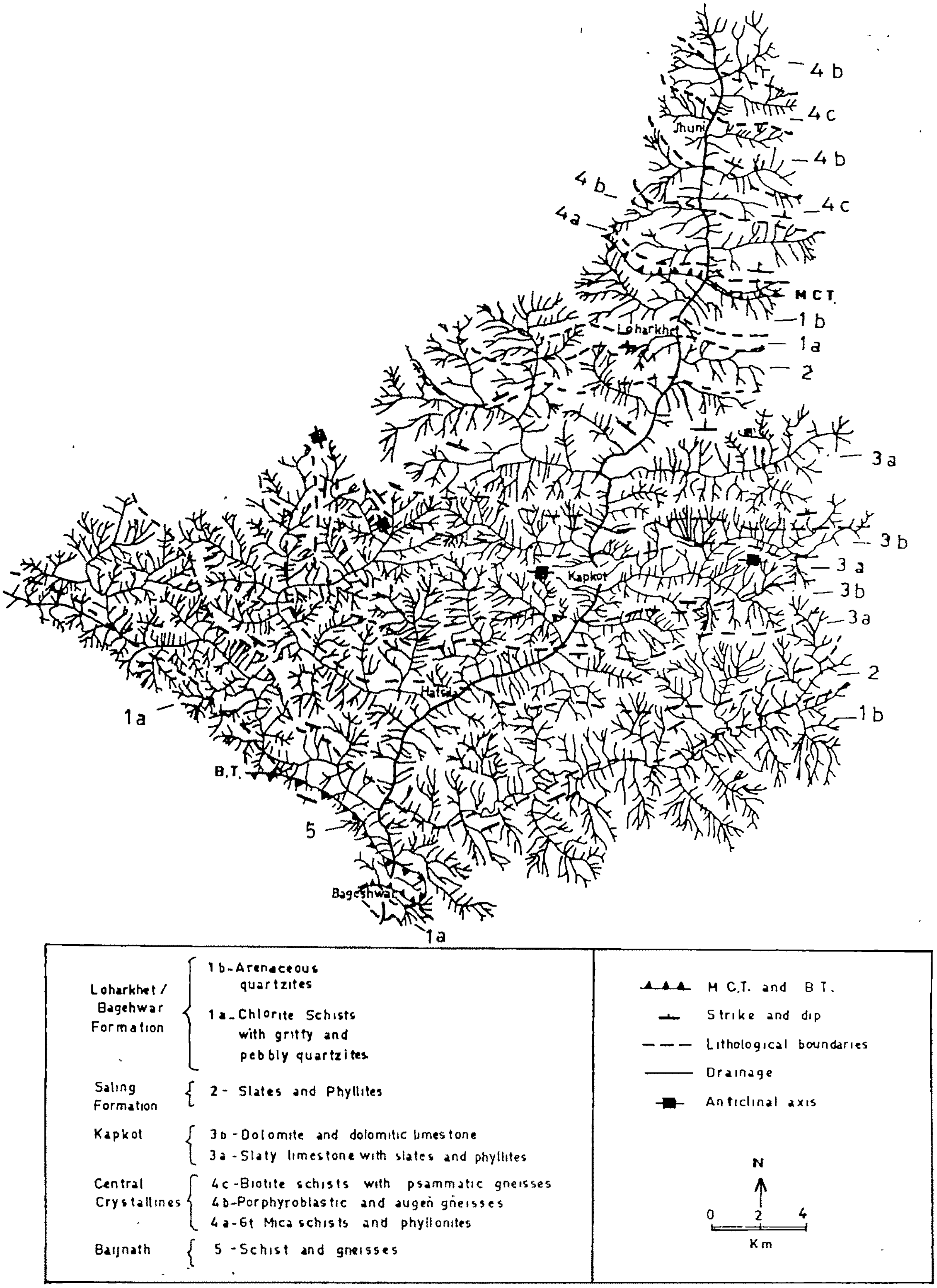

4 b
4 c
Jhuni
4 b
4 b
4 c
4a
M C T.
1 b
Loharkhet
1 a
2
3 a
3 b
3 a
Kapkot
3 b
3 a
2
1 b
Hatsila
1a
B.T.
5
Bageshwar
1a
Loharkhet / Bagehwar Formation
1 b-Arenaceous quartzites
1 a-Chlorite Schists with gritty and pebbly quartzites
Saling Formation
2 - Slates and Phyllites
Kapkot
3 b - Dolomite and dolomitic limestone
3 a - Slaty limestone with slates and phyllites
Central Crystallines
4 c - Biotite schists with psammatic gneisses
4 b-Porphyroblastic and augen gneisses
4 a-Gt Mica schists and phyllonites
Baijnath
5 - Schist and gneisses
M C.T. and B T.
Strike and dip
Lithological boundaries
Drainage
Anticlinal axis
N
0
2
4
Km

Fig. 1. Geology Superimposed over the Drainage of the Upper Sarju Basin

slates and lie with a gradational boundary below the Chandpurs termed the Saling Formation and comprise slates and phyllites. The Deobans in turn are underlain by the Bageshwar Formation which forms the southern-most lithotectonic unit of the area and is equivalent to the Loharkhet Formation. In fact, the metasedimentaries between the Baijnath Thrust in the south and M.C.T. in the north form a major anticlinal structure (Gansser, 1964; Chamyal *et al.*, 1987).

The landscape of the area drained by the river is to some extent controlled by the geological conditions. In the central crystalline zone, the landscape is very rugged with precipitous slopes and deep gorges, whereas in the Krol Belt area just south of the M C.T., steepness persists beyond Dulam but the ruggedness decreases further south in the Deoban zone, the landscape becomes more subdued, the valleys are broad with isolated peaks standing out prominently. The zone between Bageshwar and Kapkot in the south and north comprises rocks of the Krol Belt which show lesser heights. The river is very wide with well marked alluvial terraces on either side.

The fluvial environment of the Upper Sarju basin, is divisible into the following three microenvironments :

1. Channel microenvironment
2. Flood-plain microenvironment
3. Terrace (youngest) microenvironment

Samples from all the three micro-environments were collected.

Heavy Mineral Analysis

The averages of the various heavy minerals, in the three microenvironments are shown in Table 1, Fig.2 shows the graphic representation of Bar and Pie diagrams of the various minerals.

50 samples were collected around four stations i.e. Gansi, Dulam, Hatsila and Bageshwar along the main channel between Jhuni and Bageshwar (Fig.1). 30 and 25 samples were collected from the terrace (youngest) and flood plain microenvironment respectively. 20 gm of each of the sediments were taken for heavy mineral separation. The detrital grains were treated with acetic acid and the ferruginous grains with hydrochloric acid. The clay fractions were separated by the decantation method. The samples were washed, dried and the bromoform method was followed for the separation of heavy minerals.

The heavy mineral identified in the Upper Sarju River are; zircon, rutile, garnet, biotite, chlorite, limonite, magnetite, ilmenite, hematite, staurolite, kyanite, sillimanite, tourmaline and epidote.

Table 1

Average heavy mineral content in the fluvial microenvironments of Upper Sarju River

Heavy minerals	Channel	Flood-plain	Terraces
Zircon	5.36	3.65	4.37
Tourmaline	8.71	8.97	8.49
Rutile	2.51	2.92	1.62
Garnet	11.47	10.39	9.32
Chlorite	7.44	6.77	7.94
Biotite	3.43	5.98	7.81
Epidote	4.33	4.79	4.28
Limonite	12.63	13.90	12.76
Magnetite	16.19	14.88	15.50
Hematite	15.22	15.13	14.97
Ilmenite	6.89	6.32	6.72
Staurolite	3.72	4.74	4.50
Kyanite	1.59	1.07	1.20
Sillimanite	0.63	0.49	0.52

Of the heavy mineral assemblage in the channel deposits, zircon constitutes 3% to 6.76% around Gansi, 4.23% to 7.65% around Dulam, 4.52% to 7.26% around Hatsila and 4.29% to 5.21% around Bageshwar. It does not exceed 5% of the total assamblage in the terraces in any of the localities mentioned above. In the flood plain microenvironment it varies between 1.2% to 4.02% at all the studied stations. The significant proportion of the non-opaque heavies is marked by the presence of tourmaline. This mineral constitutes the maximum of 17 3% in channel deposits, 9.4% in terrace deposits and 21.2% in flood plain deposits. The average percentages of zircon and tourmaline show a gradual decline from the channel through terrace to flood plain microenvironment in the basin.

Rutile constitutes a minor proportion of heavy mineral assemblages in all the three microenvironments. The average of the averages of this mineral at four stations does not exceed 2.51% of the assemblage in the channel microenvironment, 2.62% in the terraces and 2.92% in the flood plain microenvironment. It also varies from channel to terrace to flood plaint microenvironment in increasing order.

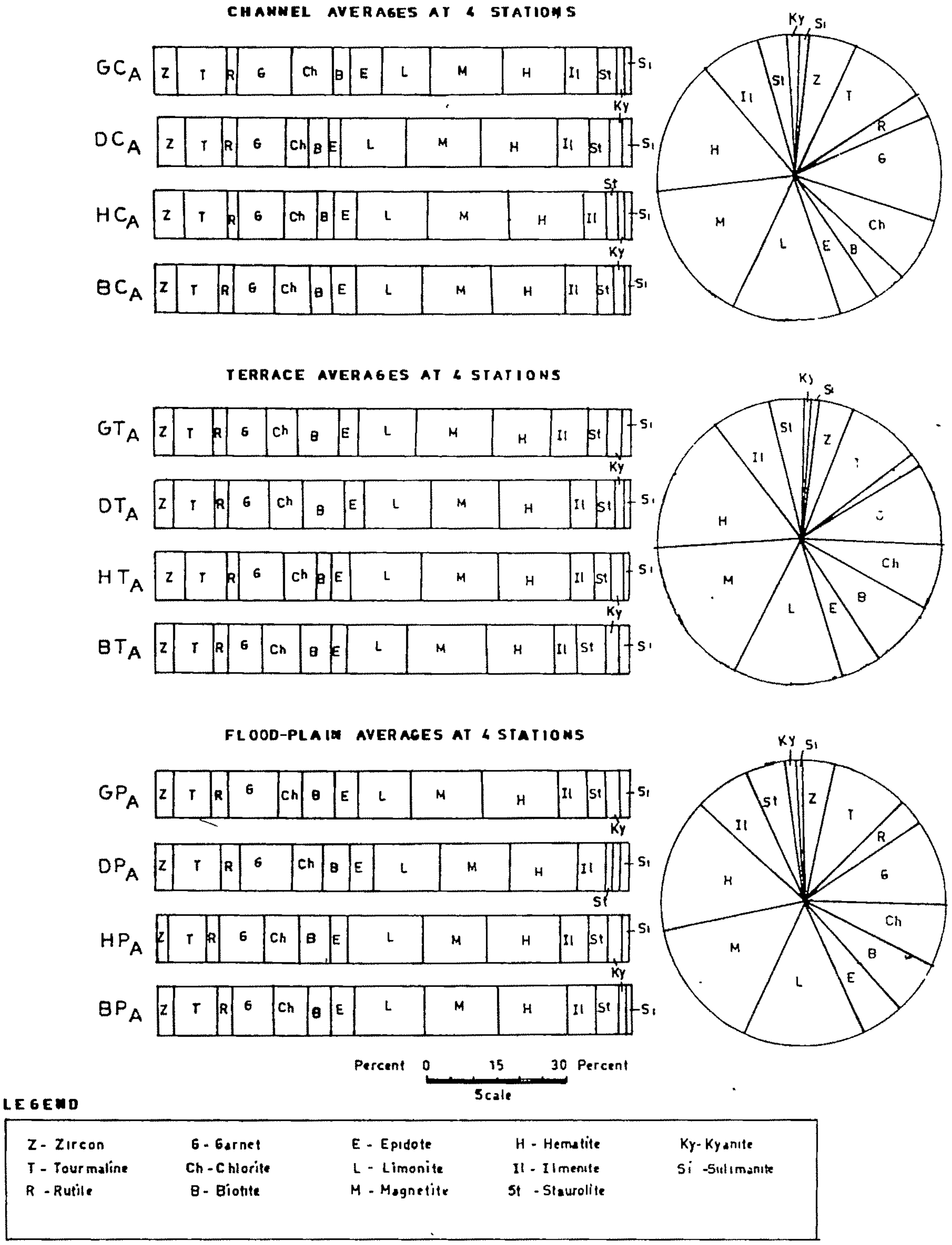
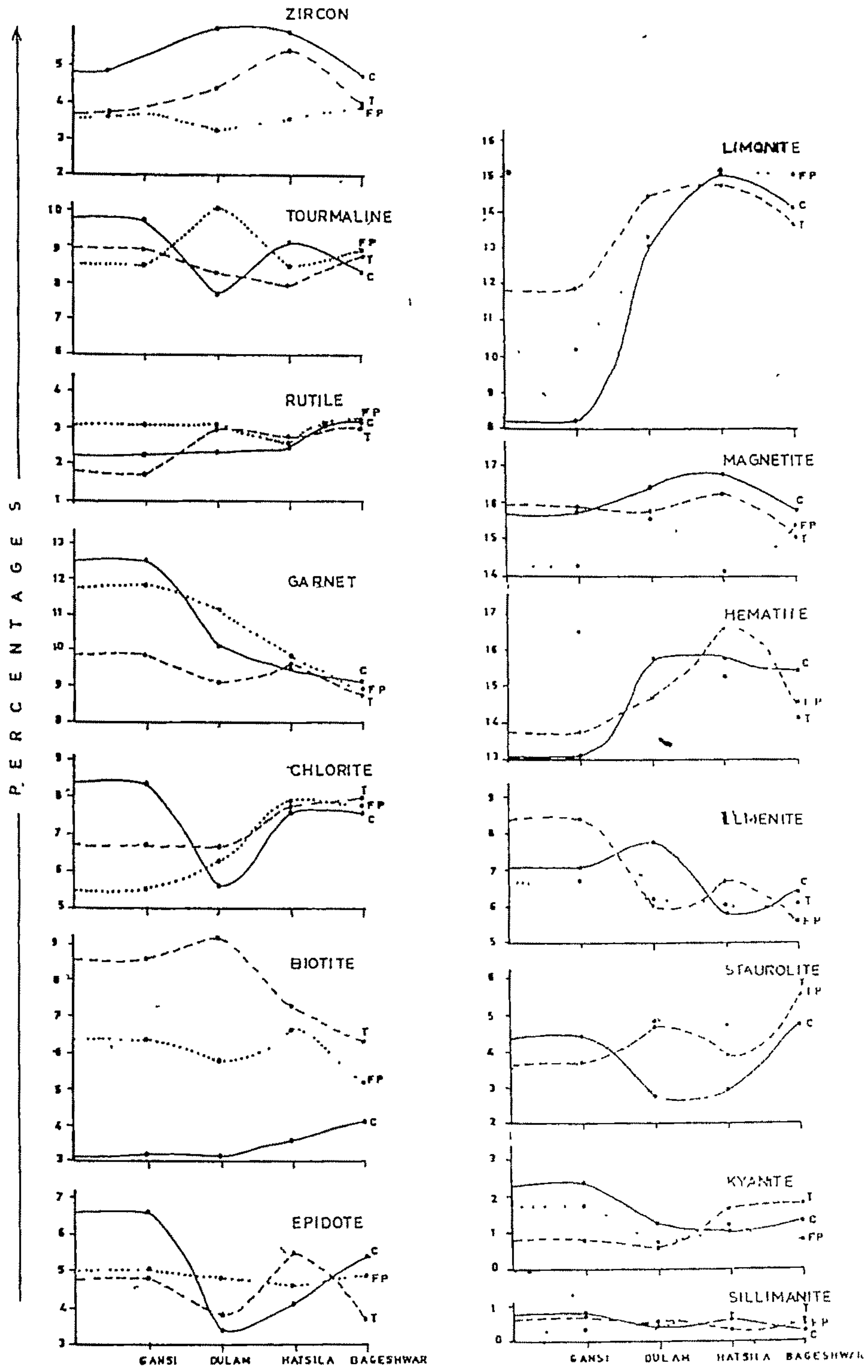


Fig.2. Bar and Pi Diagram showing Average Heavy Mineral Frequency Distribution in the Upper Sarju River Kumaon Himalaya.



c. Channel, FP. Flood plain, T. Terrace

Fig. 3. Variation Diagrams of Heavy Mineral from North to South.

Garnet is found to be the most dominant non-opaque heavy mineral. It constitutes a maximum of 12.48% (average) at Gansi and a minimum of 9.07% at Bageshwar in the channel microenvironment. Similarly in the terrace microenvironment too it decreases downstream with a maximum of 9.86% at Gansi and 8.76% (average) at Bageshwar. In the flood plain microenvironment the maximum of 11.78% at Gansi and 8.86% at Bageshwar, show that in all the three microenvironments it decreases downstream of the basin. However, of all the three microenvironments the maximum was observed in the channel microenvironment.

In the channel microenvironment epidote varies in proportion from a maximum of 6.56% at Gansi to a minimum of 3.03% at Dulam. It is found highest at Gansi with 6.56% (average) and minimum at Dulam with 3.03%. Likewise in the terrace and flood plain microenvironment also it does not show any definite trend but varies from 30.03% to 6.32%. Chlorite constitutes 7.26% (average) in the channel microenvironment, 6.77% in the flood plain and 7.8% in the terrace microenvironment. It shows an increasing trend from channel to flood plain to terrace microenvironments Similarly the average percentage of biotite varies from 3.43% in the channel to 5.98% in the flood plain to 7 81% in the terrace microenvironment, again proving that it is rich in the terrace microenvironment. Staurolite is found in all the three microenvironments. The maximum 5.71% (average) in the terrace and minimum 2.71% (average) in the channel microenvironment were noticed at Dulam and Bageshwar respectively. Sillimanite is found in very small amounts, less than 0.81% of the average heavy mineral percentage frequency distribution.

Ilminite, amongst the opaque minerals is less than 7.81%. Magnetite, hematite and limonite make up nearly subequal proportions of the average heavy mineral content of the basin.

To observe the north to south variation of heavy minerals in the three microenvironments of the basin, variation diagrams (Fig.3) were prepared. These variation diagrams reveal that the percentage of zircon is greater in the central part of the basin as compared to the northern and southern parts, in the channel and terrace microenvironments. In the floodplain microenvironment it does not show any definite trend. Rutile, tourmaline and epidote are devoid of any significant variation trends. However, these are more prevalent in the northern part of the basin.

Chlorite and biotite which dominate in the terrace microenvironment, show a decline from north to south. It is also observed that chlorite shows a increasing trend towards the south in the flood plain and channel microenvironments. Biotite shows a fluctuating trend in both these microenvironments.

Limonite shows an increasing trend from north to south in all the three microenvironments whereas magnetite which also shows a similar trend in the flood plain microenvironment, does not show any significant change in the terrace and channel microenvironment. Hematite shows a fluctuating trend in all the three microenvironments and it also shows a decline towards the south in the flood plain microenvironment. Ilmenite shows a decreasing trend from north to south in all the three microenvironments.

Staurolite, kyanite, sillimanite, however, do not show any significant quantitative change but their concentration is greater in the northern part compared to the southern part of the basin.

Observations

The statistical analysis of the heavy mineral percentage frequency distribution in the three microenvironments of the Upper Sarju Basin reveals that the non-flaky minerals of the Basin show a decline from channel to terrace microenvironment. This could be attributed to the density separation of the various minerals (Chaudhari and Gill, 1984). The higher density heavies settle down first in the channel microenvironment. Similar results were obtained by Chaudhari and Gill (1984) in the Ghaggar river, Haryana. No definite trend was noticed in the flood plain deposits. This may be on account of the disturbed hydraulic equilibrium during monsoon flooding.

The various variation diagrams for the heavy minerals from north to south in all the three microenvironments of the basin show some interesting data. The distribution of the heavies in the basin reveal that rutile, tourmaline, epidote, chlorite, biotite, hematite, ilmenite, staurolite, kyanite and sillimanite are found predominantly in the northern part, zircon in the central and limonite in the southern part of the basin. All these variations are attributed to the local lithology of the basin

As regards the grain-size distribution, the grains in the channel are coarser than the terrace grains. The constituents in the flood-plain microenvironment were noticed to have a mixed grain-size. The size, shape and the mineral assemblage of the fluvial sediments near the source of the river is similar to that of the parent rocks. These heavies can therefore very well be used to decipher the provenance of the sediments laid down in the fluvial environment in the geological past.

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A Preliminary Study of Pleistocene Fossils from the Middle Son Valley, Madhya Pradesh

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Introduction

This paper presents a preliminary study of the faunal distribution pattern and taxonomic groups of about 1000 fossils out of a total of 6000 collected from the Middle Son Valley. The valley (Fig.1) covers an area of 14,000 sq. km., being bounded by Bichhi in the east, Churat in the west, Kaimur in the north and the junction of the rivers Son and Gopad in the south. The Quaternary geology of the area is very varied and can be subdivided into four formations, namely (from top to bottom) Khetaunhi Formation, Baghor Formation, Patpara Formation and Sihawal Formation (Fig.2). Lithological units of these formations, their faunal and cultural associations, approximate ages and probable environment are summarised in Table I.

The Baghor Formation, which is divided into a basal coarse member and an overlying fine member, is by far the most fossiliferous horizon in the area. Most of the fossils come from the course member, designated as Unit II. More than 40 fossil localities have been identified in this unit alone. 5 to 10 % of the total collection of the fossils comes from the junction of the Patpara Formation and Baghor Formation, designated as Unit I. Generally the fossils from Unit I are stained red indicating the presence of iron oxide minerals in this unit. No fossils have yet been found in the Sihawal Formation, but a couple of fossil localities have been reported from the Khetaunhi Formation though they are not well documented. For more details of the alluvial history and geomorphology of the Middle Son Valley, reference may be made to the works of Pal (1980-81) and Williams and Royce (1982).

Faunal Material and Palaeoenvironment

In general the fauna is represented by complete skulls, limb bones, dental and other osteological parts. Though, the majority of the fossils are broken or fragmentary, nevertheless they are not beyond reconstruction and identification, except in a few cases. Taphonomic observations indicate that about 50% of the fauna is unabraded and has not suffered from as much fluvial activity and transportation as the fauna of the Narmada Valley. The preservation and surface texture of the fossils analysed so far seem to suggest that most of them have not been transported for long distances from their place of death or burial, though they cannot be regarded as strictly autochthonous. The Baghor Formation, which comprises silts, sands and clays, basically represents a channel-fill deposit where bones have been transported only for short distances or some of them may be treated as autochthonous with respect to local channels. The junction of the Patpara and Baghor Formations, comprising pebbly, gravelly clays and sands might partly represent channel-lag deposits preserving large, heavier and robust faunal elements though these are fewer in number as compared to the Baghor Formation. These faunal elements are usually treated as allochthonous (Behrensmeyer 1988). On the whole in both the units the faunal elements are well sorted and have accumulated gradually over long periods of time. Some of the evidences of subaerial weathering like cracking, flaking, splitting and different types of breakages are reflected in the faunal material. The connective tissues of the ends of long bones are affected by gnawing and in some cases by bacterial activity.

The presence of animals like barking deer (*Muntiacus muntjak*), hog deer (*Axis porcinus*), antelope (*Antilope cer-*

vicapra), Chital (*Axis axis*), gazella (*Gazella gazella*), nilgai (*Boselephas tragocamelus*), sambar deer (*Cervus unicolour*) and barasingha (*Cervus duvauceli*) which are similar to the ones found in archaeological sites suggests that these animals may have had a longer geological history than hitherto thought, i.e., from late Pleistocene to Holocene. It will be interesting to see if these fossils have undergone any micro-morphological changes in their osteology during this time span. However, this does not appear likely in view of the brief time span involved. The other species of fossils found from the area under study (*Bos namadicus, Equus namadicus, Elephas namadicus* etc.) generally range from Middle to Late Pleistocene and this is also confirmed by our faunal studies from the various other peninsular river valleys (Badam 1979). In most of the river valleys, fossils ranging from late Pleistocene to Holocene are rare except for a few occurrences in the Belan -Seoti Valleys (Dassarma and Biswas 1976) and the Gandeshwary Valley in West Bengal (Dassarma *et al.* 1982). Among the late Pleistocene - Holocene fossils, *Cervus unicolour, Axis axis* and *Antilope cervicapra* have been found from the Manjra Valley (Badam *et al.* 1984) while only *Antilope cervicapra* has so far been reported from the Narmada Valley (Badam 1988). It is possible that the diversity of the taxa from the Middle Pleistocene to Holocene of the Middle Son Valley, when studied in detail, can help us in putting the fauna and its associates cultures in a more accurate chronological framework than has been done before. However, the importance of faunal studies in attempting to reconstruct a chronological framework for the Middle Son Valley is now beginning to be appreciated.

In their preliminary report on the terminal Pleistocene fossils from the area under study, Blumenschine and Chattopadhyaya (1982) have postulated that in the area there were large tracts of open grassland, bushes and swamps. It may be premature at this stage to deduce definite palaeoecological inferences other than what has been offered by these two authors. The grass cover may have been thick with intermittent swamps for the large varieties of bovids, antelopes and cervids which roamed and flourished in the Valley. Seasonal forests and swamps must have existed in some of the areas of the Valley as evidenced by the presence of gavials, turtles, rhinoceroses and hippopotamii. This situation more or less also prevails in the Belan, Mahanadi and Narmada Valleys (Badam 1984). However, since each geological unit and faunal assemblage may have its own ecological and taphonomic history, the present inferences are only tentative and need to be substantiated by studies on flora, sedimentology and soil chemistry, once all the faunal material has been analysed and carefully studied. On the whole the faunal content and geological features of the Middle Son Valley fit in well with the situation obtaining in other river valleys in Central and Peninsular India. The presence of Upper Palaeolithic sites scattered along these river valleys attest to the extensive occupation by Upper Palaeolithic man of these areas in spite of the prevailing arid climatic conditions during the terminal Pleistocene (Rajaguru 1983).

It may be worthwhile to attempt to present here a combined picture of the late Pleistocene climatic picture comparing the data available from the Peninsular river valleys with the data

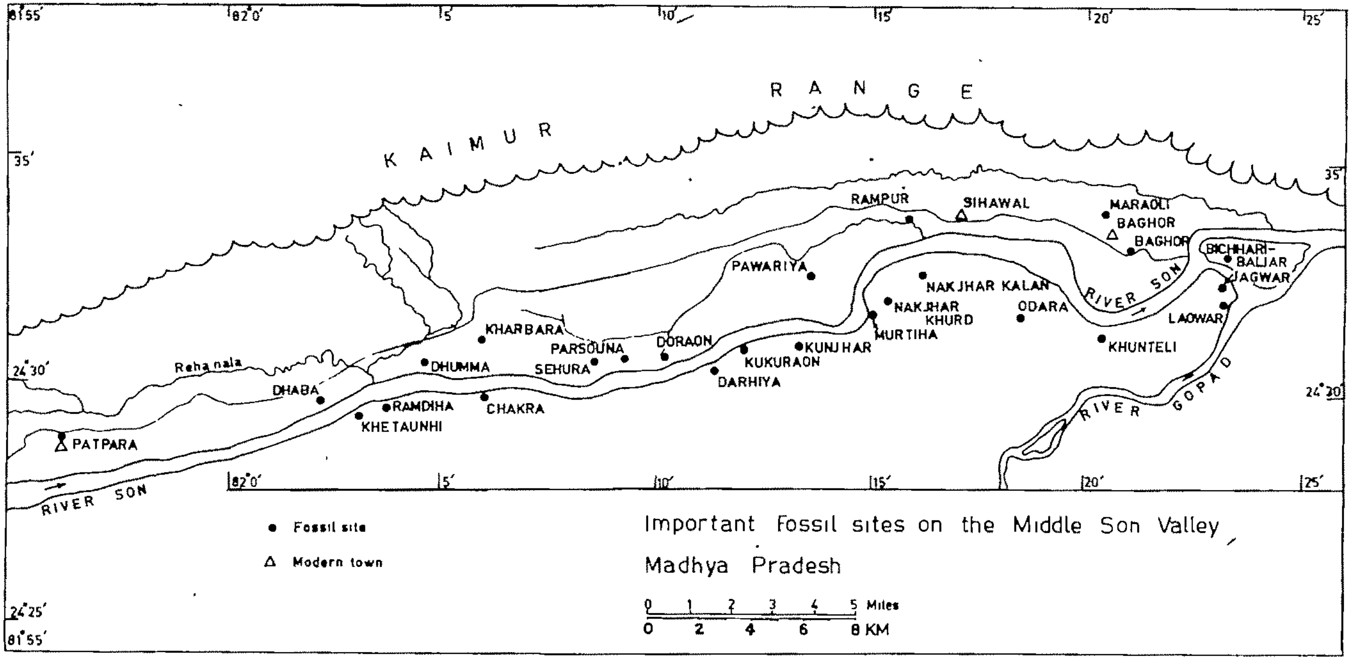

Fig. 1. Locality Map of the Middle Son Valley Showing Important Fossil Localities.

now available from the Son Valley. Certain rivers in western Maharashtra like the Manjra (a southerly tributary of the Godavari) originate in a semi- arid region, for the most part flow over the same tract and still preserve abundant animal fossils in pockets in the Pleistocene deposits which unconformably overlie the Deccan Traps. The situation here is semi-arid and dry with seasonal supply of water. At Inamgaon, on the river Ghod, we have a semi-arid situation with perennial water supply from a river originating in the Western Ghats. In the Son Valley, which has a sub-humid climate, there is also a perennial supply of water. The situation here may not have been much different from the Narmada, Manjra and Ghod in the faunal content and cultural material. In all these three cases, which represent slightly different micro-ecological zones, the survival of the animals has interestingly not been affected. Since large animals have a tremendous ability to adjust to changed climatic situations, the faunal material is prolific in these river valleys during the terminal Pleistocene aridity. Future geomorphological, sedimentological and micro-palaeontological work in these different situations may help us to differentiate man-animal adaptations which have not been well understood so far.

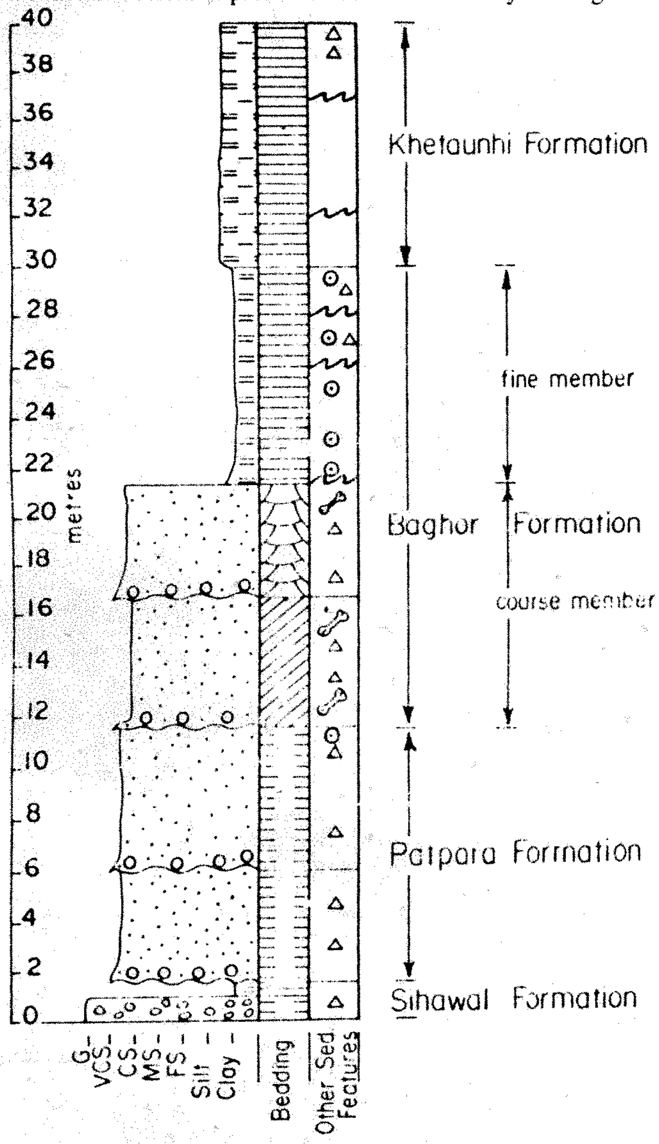

Fig.2. Composite Section of the Middle Son Valley (after Williams and Royce 1982).

It may be suggested that a riverine environment, galleria forests along the banks and flood plains of the rivers and tall grasses with sufficient pools along the channels were perhaps some of the factors responsible for the rich faunal survival. Hill slopes and areas away from the rivers must have been bare or supporting a think grass, thorn and scrub cover. Flood plain zones, channel pools (water holes) and mixed grassland - woodland environment of the flood plains were the favourable ecological niches.

In conclusion it may be said that this is only a preliminary report of the study of a partial collection of fossils from the Middle Son Valley and therefore the results arrived at can only be tentative at this stage. The study when fully completed is expected to give a better insight into the palaeontological and palaeoecological history of the faunal wealth of the Son Valley.

Notes :

(A) Fauna from the Baghor Formation (Unit II) (Figs. 3 to 7) *Bos namadicus, Bos gaurus, Bubalus* sp., *Antilope cervicapra, Boselephas tragocamelus, Tetraceros quadricornis, Gazella gazella, Axix axis, Cervus unicolor, Cervus duvauceli, Muntiacus muntjak, Sus* sp., *Hippopotamus* sp., *Rhinoceros* sp., *Equus mamadicus, Equus asinus/hemionus, Elephas* sp., *Gavialis* sp., *Trionyx* sp., *Emys* sp., Carnivores, Rodents.

(B) Fauna from the junction of the Patpara Formation and the Baghor Formation (Unit I) *Bos namadicus, Bos gaurus, Hippopotamus* sp., *Equus* sp., *Cervus* sp., *Axis axis/porcinus, Gavialis* sp.

(C) Khetaunhi Formation is essentially a terrace deposit. It has yielded a few fossils.

(D) Sihawal Formation has not yielded any fossils so far.

(E) Some of the fossils cannot be identified upto the specific level at this stage.

F) The ratio of flourine analysis ($100F/P_2O_5$)of the bones from Unit I is 4.26 and that from Unit II ranges from 7.38 to 4.03. The ratio from the Khetaunhi Formation of surface find is 5.15. These ratios on the whole fit in well with our studies on biochronology except for the value 7.38, which represents a fossil derived from an older horizon.

Table 1

Litho-, Bio-, Chrono-, and Cultural Stratigraphy of the Quaternary Deposits of the Middle Son Valley

Geological Formation	Lithological Units	Cultural Association	Approximate Age	Probable Climate
Khetaunhi Formation (10 m)	Clays, silts and sands	Mesolithic, Neolithic & Upper Palaeolithic	Mid. Holocene 10,000 Yrs.B.P.	Humid (warm wet)
Baghor Formation (20 m)	Silts, sands clays & yellow brown loam	Middle to Upper Palaeolithic	Terminal Pleistocene to Early Holocene 30,000 - 10,000 Yrs.B.P.	Humid to semi-arid (warm wet to clod dry)
Patpara Formation (10 m)	Gravelly clays and sands, reddish in colour	Middle Palaeolithic to late Acheulian	Upper Pleistocene 100,000 - 30,000 Yrs.B.P.	Humid (moist dry)
Sihawal Formation	Sands, silty clay & gravel	Lower Palaeolithic	Middle Pleistocene to early Upper Pleistocene 100,000 Yrs.B.P.	Semi-arid (dry)

(Adapted from Pal, 1980-81 and Williams and Royce, 1982)

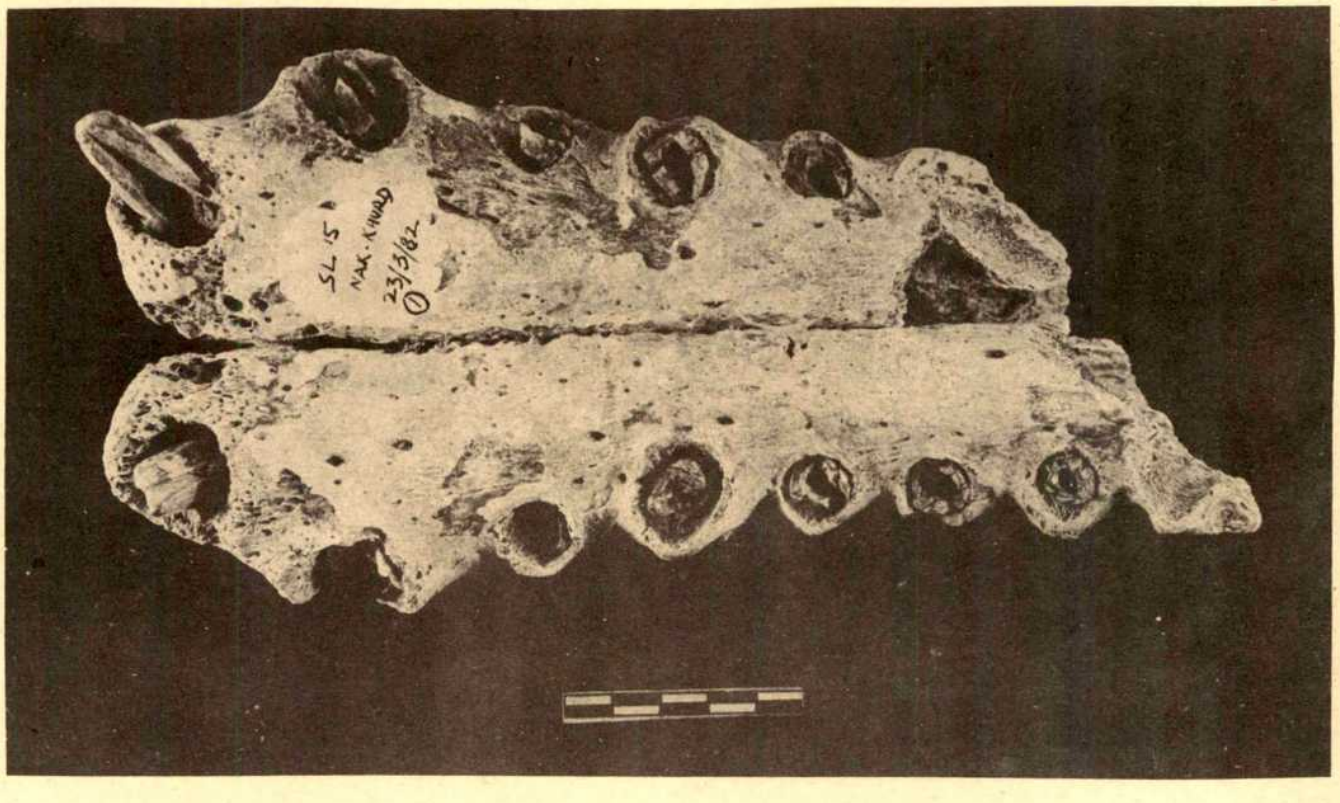

Fig.3. Maxilla of Gavialis sp. Showing Complete Teeth, Broken Teeth and Alveoli of Teeth.

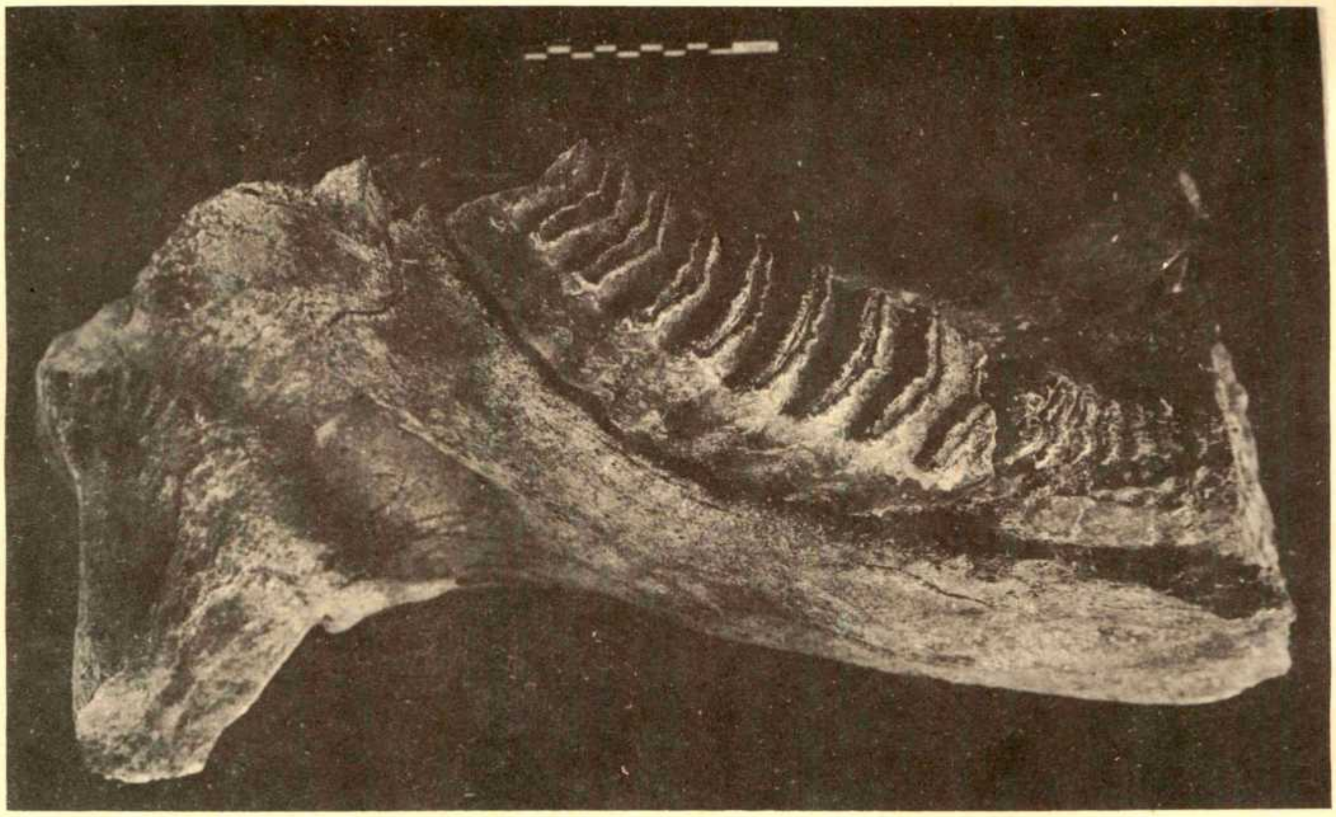

Fig.4. Right Lower Jaw of Elephas sp. with Deciduous Molars

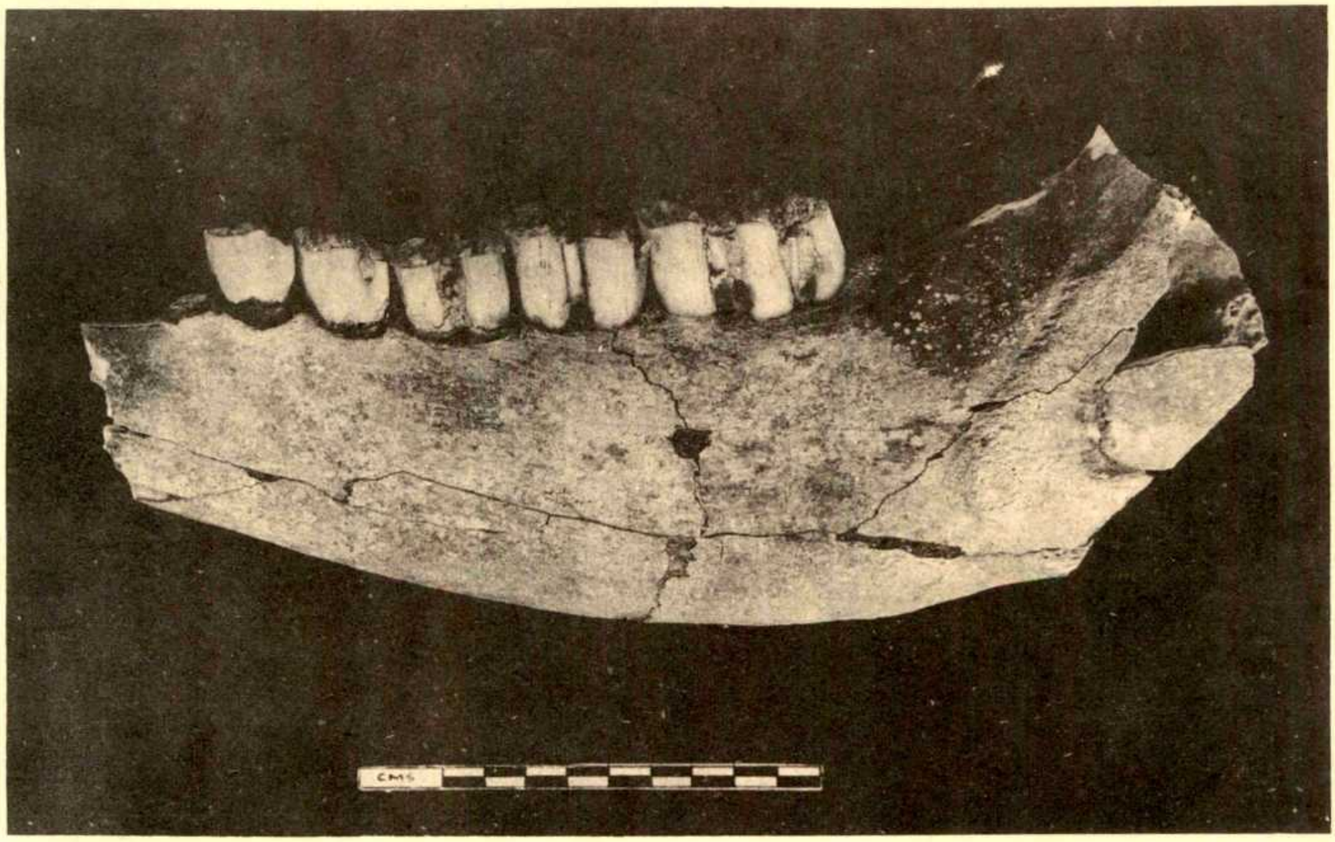

Fig.5. Left Lower Jaw of Bos namadicus with P_3 P_4, M_1 M_2 & M_3

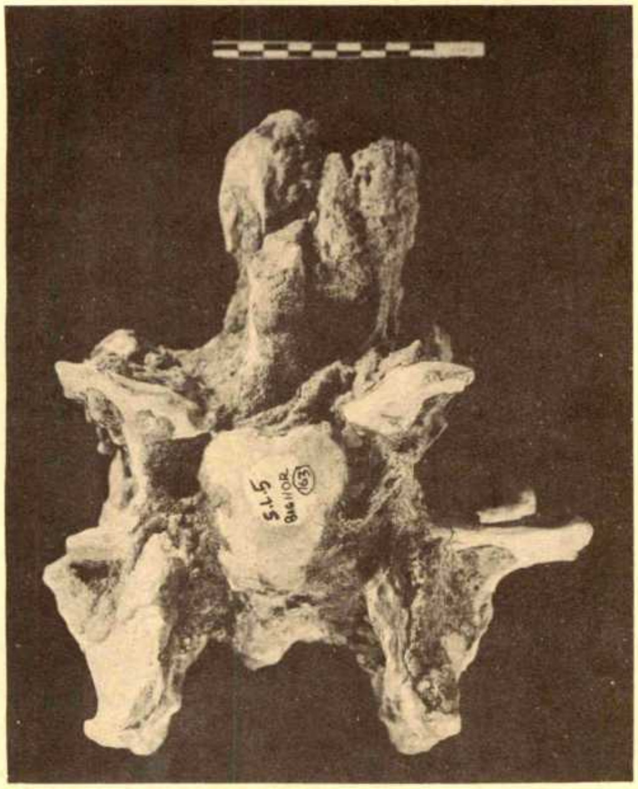

Fig. 6. Cervical Vertebra of Bos namadicus Showing Vertical Deformity in the Body. This may be due to the Compact Nature of the Sediments (as appears from the contents of the matrix) in which the bone was embedded after its burial. Mosaic Fractures are also Seen and the Effects of Abrasion are Prominent.

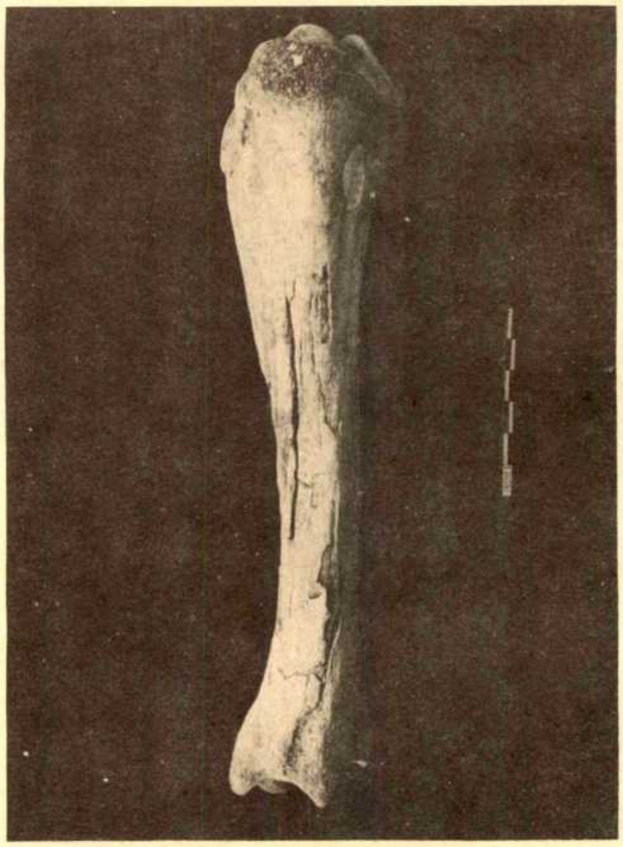

Fig. 7. Tibia of Equus sp. Showing Sub-aerial Weathering Resulting into Longitudinal Cracks and Subsequent Removal of the Outer Table of the Bone Surface. The Proximal Condylar Surface of Tibia Exhibits the Evidence of Bacterial Activity. This is Suggestive of Prolonged Exposure of the Bone in Humid-subaerial Conditions Prior to Burial.

Acknowlegements

The present work is the first report of a collaborative programme of research between the Deccan College, Pune and the Allahabad University, Allahabad. We gratefully acknowledge the help from Professor S.N.Rajaguru for his suggestions, Shri V. G. Sathe for help during preparation of the manuscript, Dr.(Mrs) A.A.Kshirsagar for providing data on flourine analysis and Professor U.N Roy, former Head of the Dept. of Ancient History, Culture and Archaeology, Allahabad University, Allahabad for extending laboratory and library facilities and also for providing assistance from technical and academic staff of his department. The award of a fellowship to the senior author by the Allahabad University to undertake the present research is gratefully acknowledged.

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A Metrical Analysis of Handaxes and Cleavers from the Acheulian Site at Gangapur, Nasik District, Maharashtra

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Introduction

The Gangapur Acheulian site is located 8 km northwest of Nasik (20° N; 73° 48' E), on the right bank of the Godavari River. It is one of the three major Acheulian sites in Western Maharashtra, the other two being Chirki-on-Pravara (Corvinus 1968) and Bori (Kale *et al.* 1986), which have both stratified and palaeontological context. The site was discovered by P.V.Sovani (1956-57 : 11) and later excavated by Joshi *et al.* (1966). The assemblage, dominated by flakes and flake tools, is comprised of handaxes, cleavers, scrapers, points, notches, blades and cores.

Archaeological studies undertaken on the site have been confined to the reporting and classification of artifacts. The present communication presents a metrical analyses of handaxes and cleavers from the site. The aim is to express objectively their size, shape and refinement, following the works of Roe (1964, 1968), Lele and Koti (1970) and Joshi and Marathe (1975-76, 1977, 1985).

Material

The sample analysed, comprising 55 cleavers and 17 handaxes, consists of material both from the author's collection as well as from the earlier collections at Deccan College and at the Prehistory Branch, Archaeological Survey of India, Nagpur.

Methodology

a) Parameters

The parameters considered in the study are weight (W), maximum length (L), maximum breadth (B), maximum thickness (T) and length of cutting edge (C).

b) Indices

i)Thickness over breadth (T/B) : This determines the refinement or flatness of an implement (a low value of the ratio is suggestive of refinement).

ii)Thickness over length (T/L) : This is also a measure of refinement of a tool.

iii)Breadth over length (B/L) : This expresses the shape of an implement in terms of broadness or narrowness (a low value indicates narrowness).

c) Statistical Variables

i) Mean ($\bar{x}$)

ii)Standard deviation (s)

iii)Coeffecient of variation (C.V.)

iv)Total correlation coeffecient (r)

v) Coefficient of determination (r^2)

vi)Test of significance (t-test)

d) Presentation of Data

i)Frequency distribution graphs (Fig.1) are drawn to show the range and preference, if any, of a particular class among various parameters of hand-

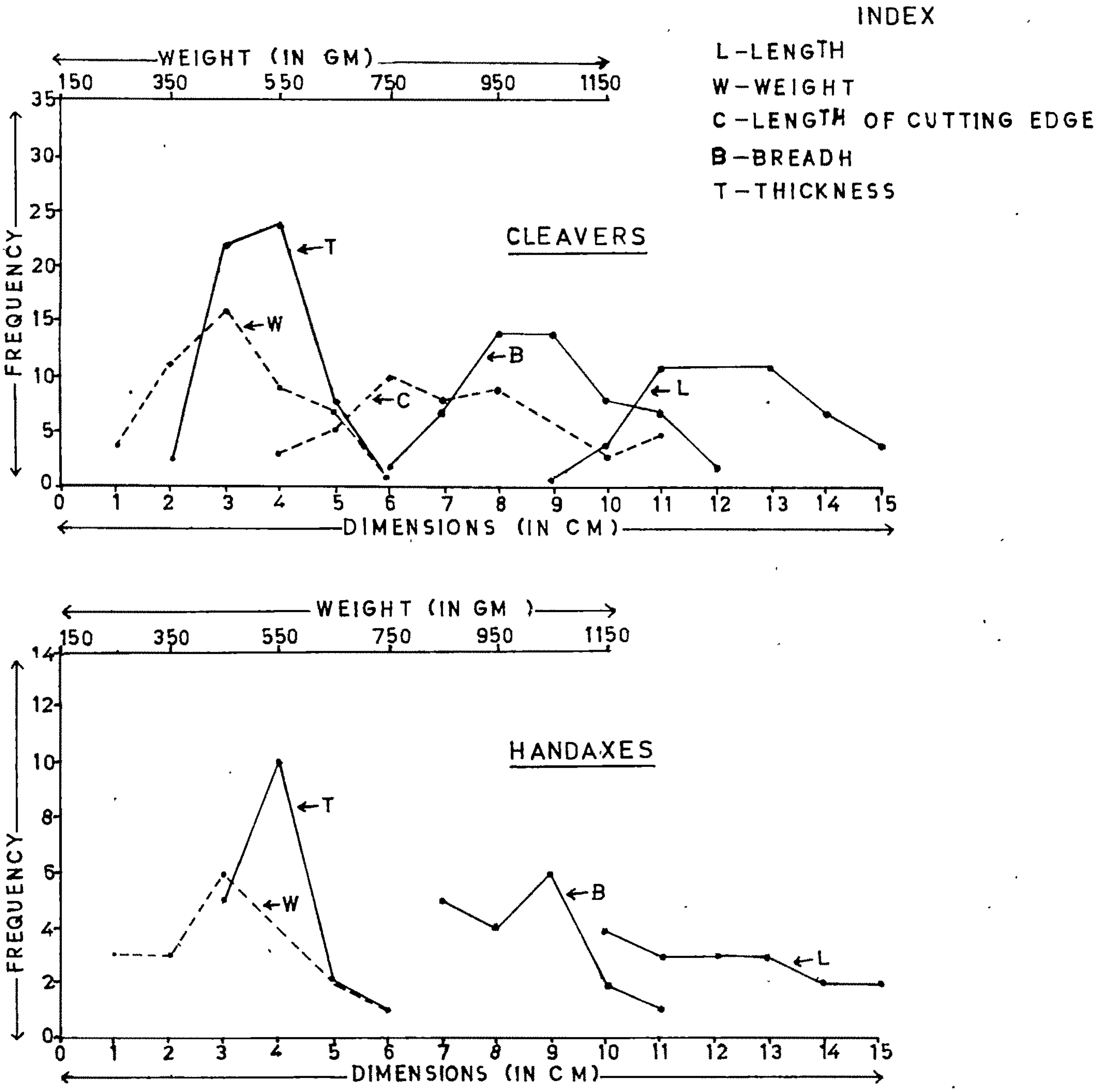


Fig. 1. Frequency Distribution of Handaxes and Cleavers from Gangapur Acheulian Site.

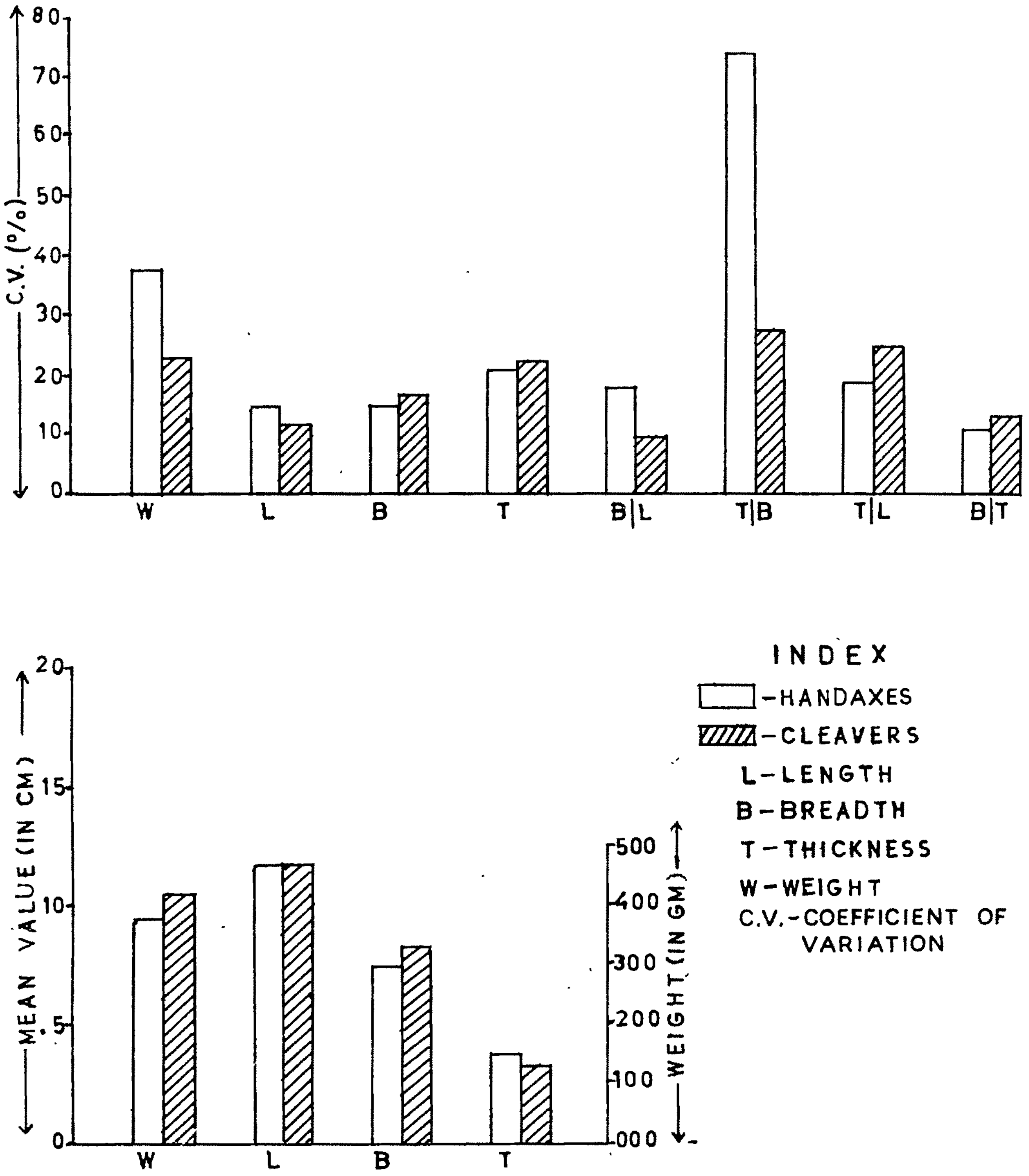


Fig.2. Comparasion of Handaxes and Cleavers from Gangapur Acheulian Site

axes and cleaver (uni-modal distribution suggests homogeneity or the standardized nature of data).

ii)Histograms (Figs. 2, 3 and 4) are drawn to compare the handaxes and cleavers within the Gangapur assemblage and also to compare them with those of other reported sites, namely, Chirki (Corvinus 1968), Paleru (Rao 1979), Wagan, Berach, Gambhiri (Misra 1967), Mayurbhang (Ghosh and Ray 1964).

iii)Plots and regression lines (Figs. 5 and 6) are drawn among length, breadth, thickness and length of cutting edge of the handaxes and cleavers to ascertain the nature of their relationship.

iv)Normal distribution graphs (Fig.7), confidence limits x ± 2s (representing 95% of an assemblage), are drawn to compare the Gangapur handaxes with those of the other sites, mentioned above.

Analysis of the Data

a) Assessment of The Variables Within The Gangapur Assemblage

i)Handaxes (Table 1). The mean dimensions of the handaxes are 11.79 cm length, 7.41 cm breadth, 3.32 cm thickness and 383.60 gm weight. The variation in length (14 50%), breadth (15 07,%) and thickness (21.20%) is moderate It is, however, substantial in the case of their weight, as evident from the value of 37.34%. The low mean values of refinement indices, namely, thickness over breadth (0.42) and thickness over length (0 27) are suggestive of their refined forms. On the other hand, the high mean value of breadth over length ratio indicates broadness of the hadaxes.

ii)Cleavers (Table 1) : The mean dimensions are 11.70 cm length, 8 20 cm breadth, 3.10 cm thickness, 6.70 cm length of cutting edge and 417.56 gm weight. The variation is low in the case of the length and breadth, as suggested by the values 11.90% and 16.70%, respectively. It is moderate to substantial in weight (23.17%) , thickness (24.51%) and length of cutting edge (29.85%). The low mean values, 0 26 and 0.39 of refinement indices, thickness over length and thickness over breadth, respectively, bring about the refined nature of the cleavers. As in case of the handaxes, the high value of the breadth over length ratio (0 68), suggests broadness of the cleavers.

b) Frequency Distribution Patterns (Fig.1) :

i)The handaxe sample shows homogeneity in weight and thickness parameters, the highest representation being 350-450 gm and 3-4 cm, respectively. Other variables, namely, breadth and length do not show dominance of any particular class, thereby, suggesting heterogeneity of these parameters in the assemblage.

ii)The cleaver sample shows homogeneity only in the weight parameter, with 350-450 gm class showing clear performance over the others. Other variables, do not show preference of any particular class, indicating the un-standardized nature of the data.

c) Correlation Among Variables (Tables 2 and 3A and 3B)

i)In the handaxes (Fig 5), a significant correlation is observed between length and thickness, using the t-test. Correlation coeffecient ($r = +0\ 62$) is indicative of a positive relation between these parameters. Coeffecient of determination ($r^2 = 0\ 38$) implies that 38% of variations in one variable are attributable to those in the other. In other pairs, viz , length and breadth, breadth and thickness, the t-test does not indicate any significant correlation.

ii)In the cleavers (Fig.6), a significant correlation is noticed between length and breadth, length and thickness, breadth and thickness and between breadth and length of the cutting edge. Among these pairs, length and thickness ($r - 0.90$) shows a negative association, while the other are positively related In the pairs, length and breadth, length and thickness and breadth and length and thickness and breadth and length of cutting edge, the high values of coeffecient of determination ($r^2 = 0.57 - 0\ 81$) are suggestive of a high dependence of variations in one variable on account of those in the other. The test of significance as well as correlation coeffecient values in the pairs, length and length of cutting edge, thickness and length of cutting edge do not bring out any significant relationship between them.

d) Comparison Of Handaxes With Cleavers (Table 1; Fig.2)

i)It is seen that the handaxes are narrower and lighter than the cleavers. However, they are thicker than the latter. In the case of their length, both are almost identical.

ii)The handaxes are less standardized than the cleavers in the case of their weight, length, breadth over length and thickness over breadth ratios. In respect to other variables and indices, they are relatively more standardized.

e) Handaxes and Cleavers From Gangapur in Relation to Other Acheulian Assemblages (Tables 4 and 5)

The comparison of the Gangapur handaxes and

Table 1

Comparative Analysis of Handaxes and Cleavers

S.No.	Parameters	$\bar{x}$		s		C.V.	
		Handaxes	Cleavers	Handaxes	Cleavers	Handaxes	Cleavers
1	Weight(in gm) (W)	383.60 a (15)	417.46 (49)	143.25	96.76	37.34	23.17
2	Length(in cm) (L)	11.79 (17)	11.70 (49)	1.70	1.50	14.50	11.90
3	Breadth(in cm) (B)	7.41 (17)	8.20 (53)	1.10	1.47	15.07	16.70
4	Thickness(in cm) (T)	3.32 (17)	3.10 (55)	0.70	0.76	21.20	24.51
5	Length of(in cm) Cutting edge (C)	--	6.70 (48)	--	2.00	--	29.85
6	B/L	0.64 (17)	0.68 (47)	0.11	0.07	17.18	10.29
7	T/B	0.42 (17)	0.39 (53)	0.31	0.11	73.80	28.20
8	T/L	0.27 (17)	0.26 (49)	0.05	0.09	18.51	34.60

(a = Number of Artifacts)

Table 2

Regression Equations of Gangapur Handaxes and Cleavers

A: Handexes:
1) Length = -0.87 + 1.59 B
2) Breadth = 4.34 + 0.30 L
3) Breadth = 3.92 + 1.18 T
4) Thickness = 3.05 + 0.03 B
5) Length = 7.13 + 1.32 T
6) Thickness = 1.10 + 0.19 L

B: Cleavers:
1) Length = 7.29 + o.55 B
2) Breadth = 3.72 + 0.38 L
3) Length = 14.82 - 0.96 T
4) Thickness = 22.80 - 1.67 L
5) Breadth = 9.92 - 0.52 T
6) Thickness = 4.82 - 0.20 B
7) Length of cutting edge = -1.52 + 0.70 L
8) Length = 8.74 + 0.45 C
9) Breadth = 4.60 + 0.53 C
10) Length at cutting edge = -3.65 + 1.54 B
11) Thickness = 3.57 - 0.06 C
12) Length of cutting edge = 7.72 - 0.30 T

53

Table 3(A)

Correlation Coeffecients of Paired Variables

S.No.	Tool Type	Length and Breadth (LB)	Length and Thickness (LT)	Breadth and Thickness (BT)	Length and Length of Cutting Edge (LC)	Breadth and Length of Cutting Edge (BC)	Thickness and Length of Cutting Edge (TC)
1	Handaxe	-0.45	+0.62	+0.03	--	--	--
2	Cleaver	+0.76	-0.96	+0.33	+0.10	+0.76	+0.13

Table 3(B)

t - test Analysis of Correlation Coeffecients

S.No.	Tool Type	Length and Breadth (LB)		Length and Thickness (LT)		Breadth and Thickness (BT)		Length and Length of Cutting Edge (LC)		Breadth and Length of Cutting Edge (BC)		Thickness and Length of Cutting Edge (TC)	
		Cal.	Tab.[b]	Cal.	Tab.	Cal.	Tab.	Cal.	Tab.	Cal.	Tab.	Cal.	Tab.
1	Handaxe	1.95 (15)[a]	2.13	3.07 (15)	2.13	0.11 (15)	2.13	--	--	--	--	--	--
2	Cleaver	7.83 (45)	2.01	14.34 (47)	2.01	2.50 (51)	2.00	0.67 (45)	2.01	7.83 (45)	2.01	0.88 (46)	2.01

(a - Degree of Freedom; b - At 0.05% level of significance;
Cal. - Calculated; Tab. - Tabulated)

Table 4

Comparative Analysis of Gangapur Handaxes with other Sites

Parameters	Statistical Variables	Gangapur(17)[a]	Berach(22)	Gambhiri(25)	Wagan(35)	Chirki(88)	Paleru(172)
1. Weight (W)	$\bar{x}$ (in cm)	383.60	--	--	--	539.23	210.84
	s	143.25	--	--	--	171.43	105.19
	C.V.	37.34	--	--	--	31.77	46.51
2. Length (L)	$\bar{x}$ (in cm)	11.79	11.63	13.28	10.60	13.79	9.80
	s	1.70	2.15	2.91	1.95	3.77	1.74
	C.V.	14.50	15.40	21.74	18.39	27.00	17.78
3. Breadth (B)	$\bar{x}$ (in cm)	7.41	8.05	8.05	7.70	7.63	6.89
	s	1.10	1.74	1.74	1.90	,30	1.06
	C.V.	15.07	21.61	21.61	24.67	3.97	15.37
4. Thickness (T)	$\bar{x}$ (in cm)	3.32	3.91	4.58	3.80	4.81	3.06
	s	.70	1.09	1.31	.98	1.26	.66
	C.V.	21.20	27.72	28.50	24.67	25.13	21.42
5. Breadth/Length (B/L)	$\bar{x}$	.64	.68	.68	.07	--	--
	s	.11	.08	.08	.12	--	--
	C.V.	17.18	11.76	11.76	17.90	--	--
6. Thickness/Breadth (T/B)	$\bar{x}$	.42	.49	.49	.54	--	--
	s	.31	.09	.09	.12	--	--
	C.V.	73.80	18.36	18.36	22.22	--	--
7. Thickness/Length (T/L)	$\bar{x}$	.27	.34	.38	36	--	--
	s	.05	.07	.08	.06	--	--
	C.V.	18.51	20.58	21.05	16.61	--	--

(a: Number of Handaxes)

Table 5:
Comparative Analysis of Gangapur Cleavers with Other Sites

Parameters		Gangapur (55) a	Chirki (100)	Mayurbanj (60)
Weight	$\bar{X}$ (In gm)	417.56	561.22	577.40
	s	96.76	193.10	232.93
	C.V.	23.17	34.71	40.34
Length	$\bar{X}$ (In cm)	11.70	13.63	13.77
	s	1.50	1.94	2.11
	C.V.	11.90	14.22	15.32
Breadth	$\bar{X}$ (In cm)	8.20	7.74	--
	s	1.47	1.09	--
	C.V.	16.70	14.22	--
Thickness	$\bar{X}$ (In cm)	3.10	4.71	--
	s	.76	.79	--
	C.V.	24.51	16.77	--
Length of Cutting Edge	$\bar{X}$ (In cm)	6.70	7.04	--
	s	2.00	2.27	--
	C.V.	29.85	32.24	--
Raw Material	--	Basalt	Basalt	Quartzite

(a: Number of Cleavers)

cleavers with the Chirki, Paleru, Berach, Gambhiri, Wagan and Mayurbhanj assemblages, allows for the following deductions:

i)The Gangapur handaxes (Fig.3) are shorter than those from Chirki and Gambhiri, longer than the Paleru and Wagon ones, while they are equal in length to the Berach handaxes.

ii)In breadth, the Gangapur handaxes are narrower than the Berach and Gambhiri handaxes, but broader than the Paleru and ones., In comparison to the Chirki handaxes, no appreciable difference is noticed in this variable.

iii)In thickness, the Gangapur handaxes are thinner than the Chirki and Gambhiri ones. On the other hand, they are equal in breadth to the handaxes from the Paleru, Berach and Wagan.

iv)In weight, the Gangapur handaxes are lighter than the Chirki ones but heavier than the Paleru ones.

v)In both refinement indices, thickness over length and thickness over breadth; the Gangapur handaxes are found marginally more refined than the handaxes from the other sites under comparison.

vi)In shape index, breadth over length, the Gangapur handaxes are comparable in broadness to the handaxes from Berach, Gambhiri and Wagan.

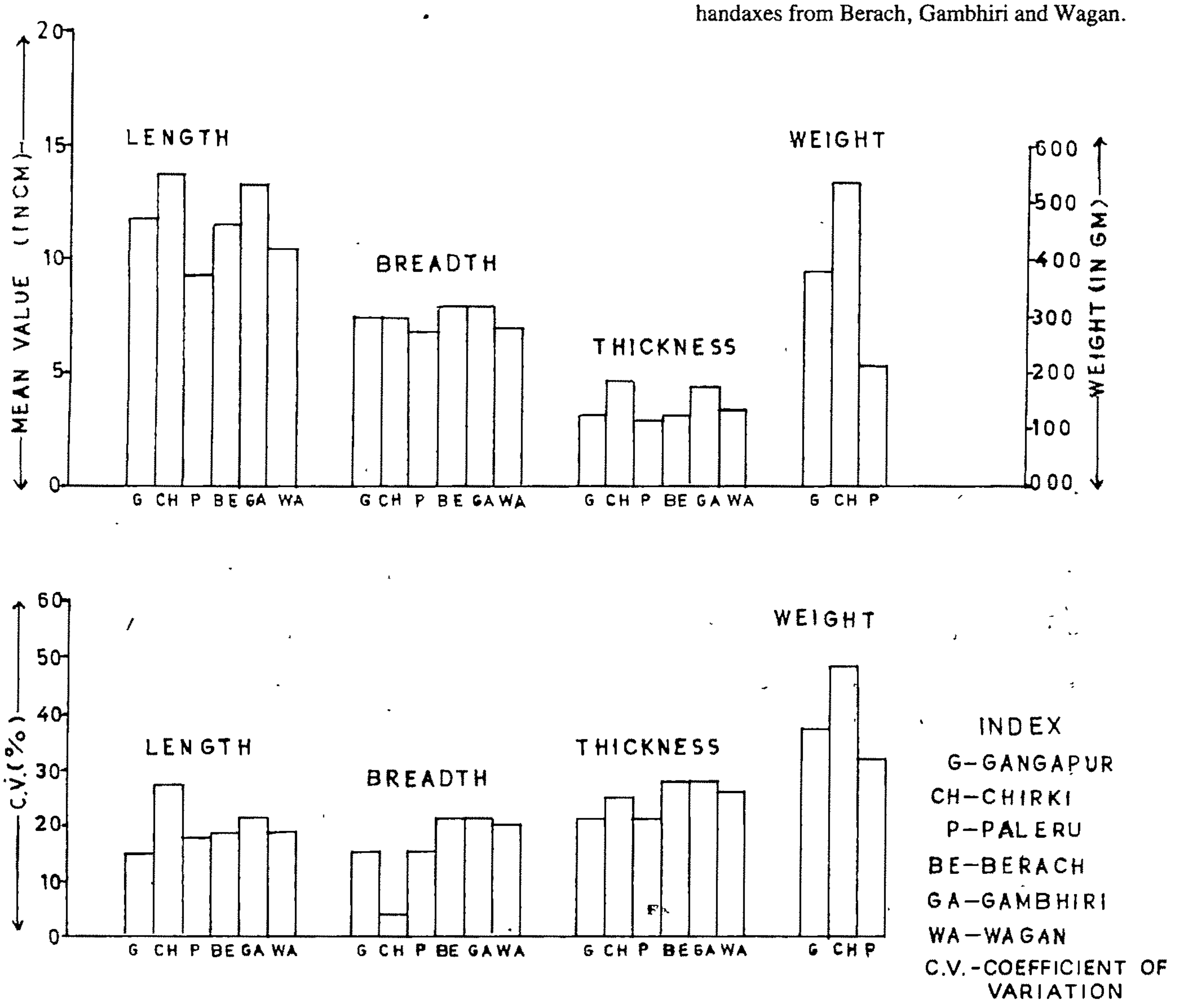


Fig.3. Comparision of Gangapur Handaxes with that of Other Acheulian Industries

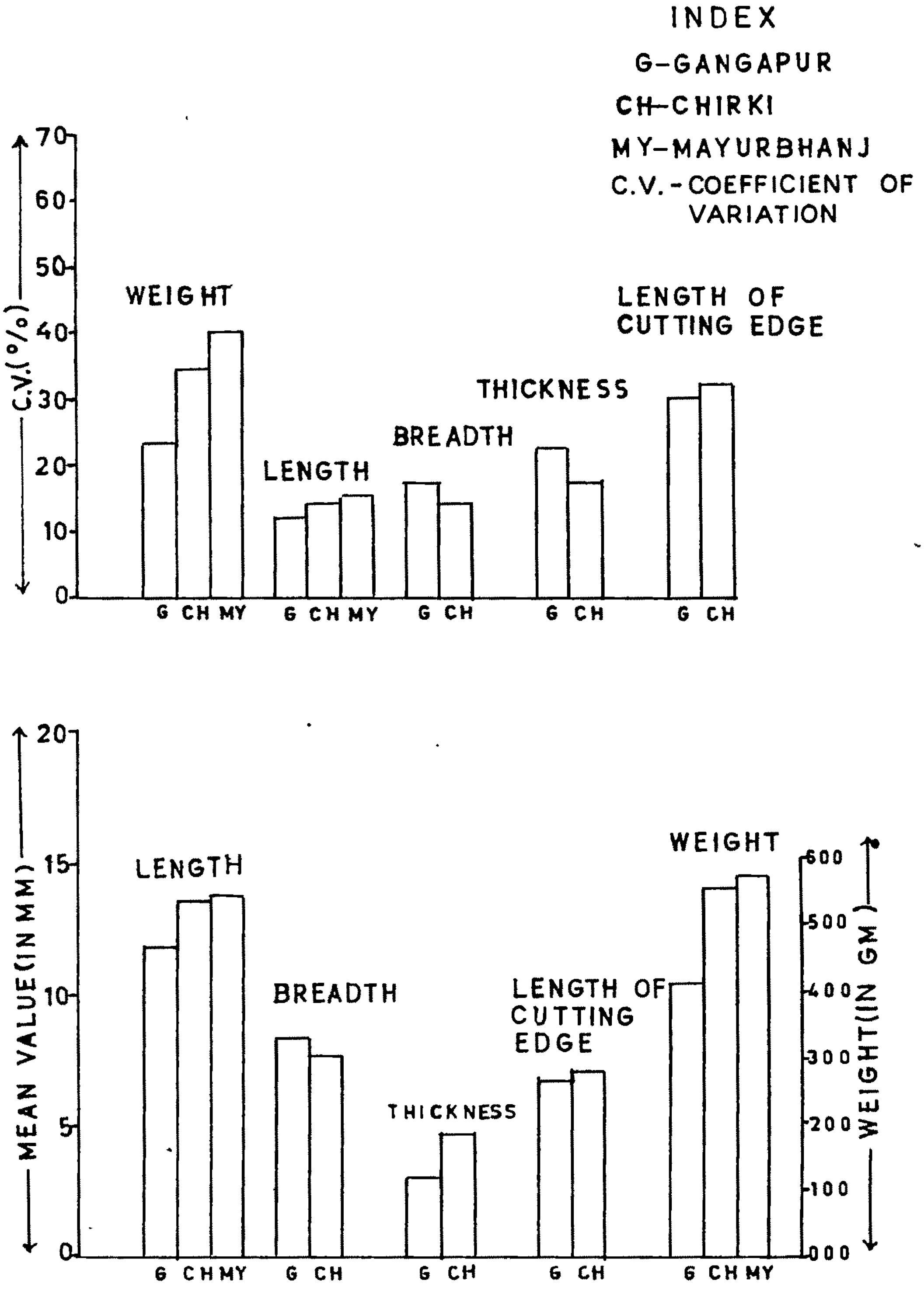
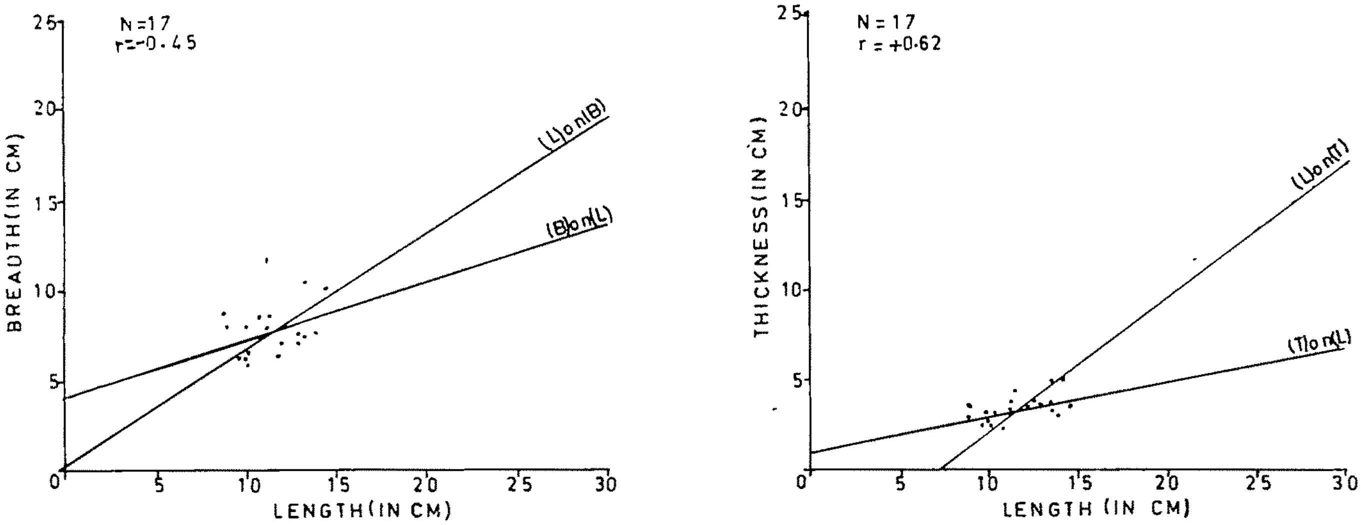


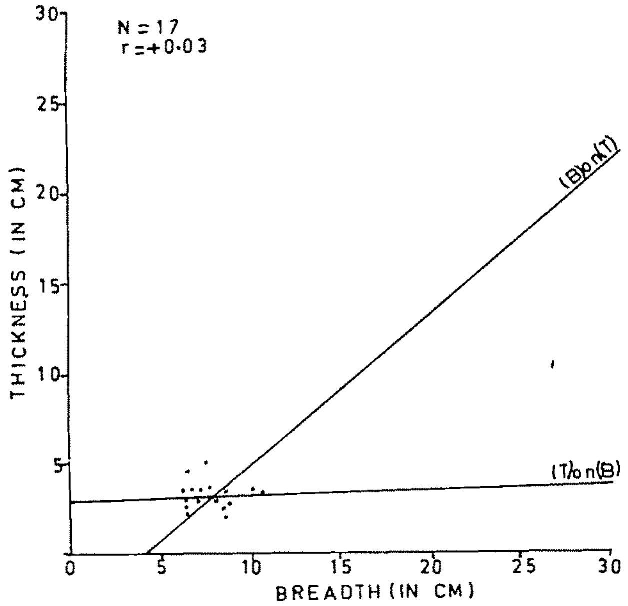
Fig.4. Comparision of Gangapur Cleavers with that of Other Acheulian Industries

vii)In the case of cleavers (Fig.4), they are found to be lighter and shorter than the Chirki and Mayurbhanj ones. They are thinner, broader and have a shorter cutting edge than the former. They also show relatively more standardization in the variables - length, weight and length of cutting edge.



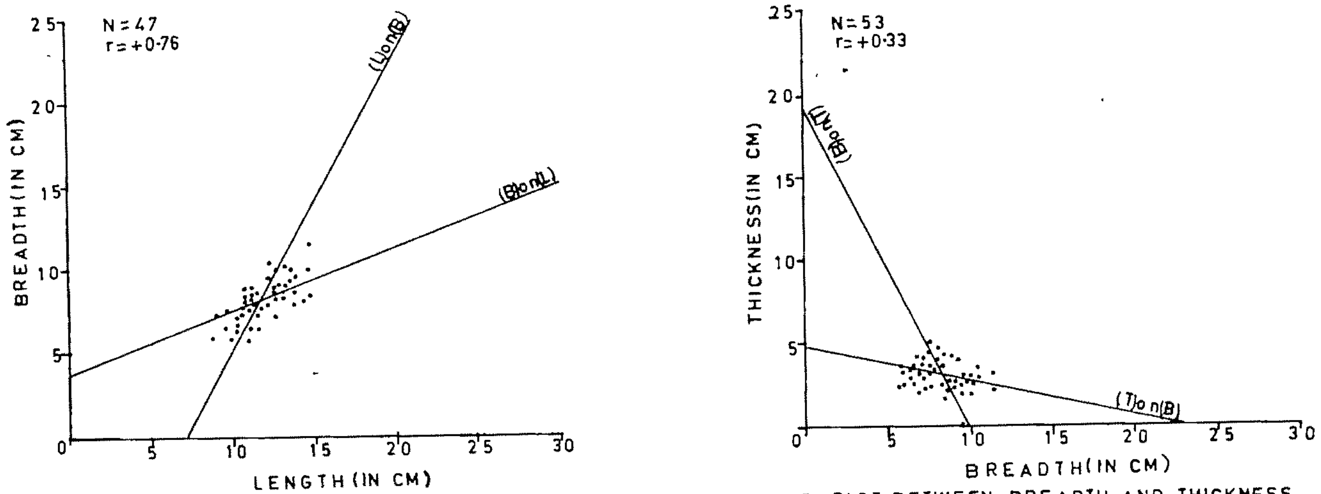
A: PLOT BETWEEN LENGTH AND BREADTH

B: PLOT BETWEEN LENGTH AND THICKNESS



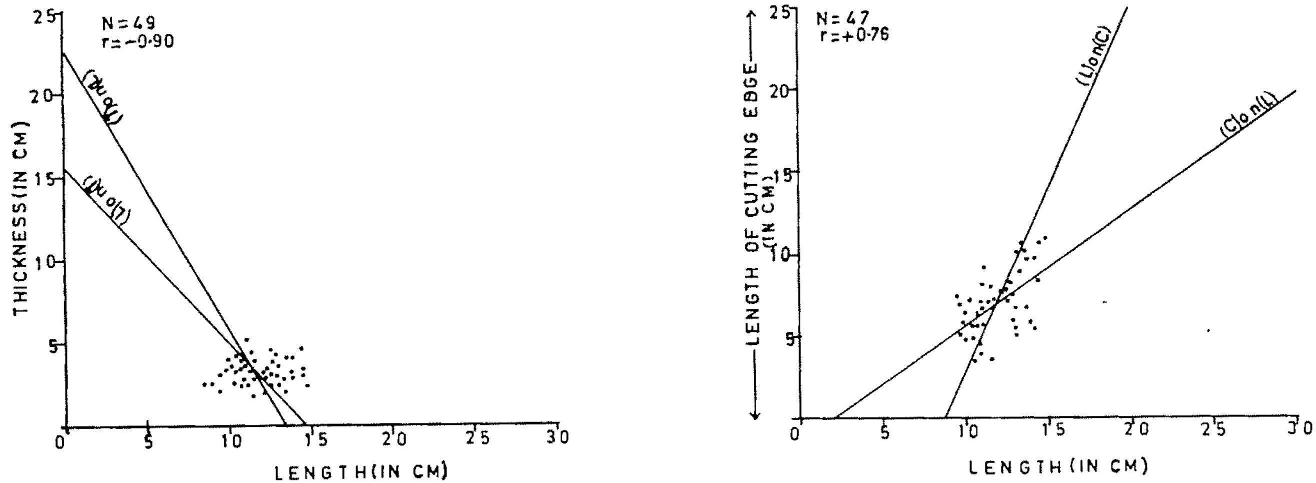
C PLOT BETWEEN BREADTH AND THICKNESS

Fig 5 Plots and Regression Lines among Various Parameters of Handaxes from Gangapur Acheulian Industry



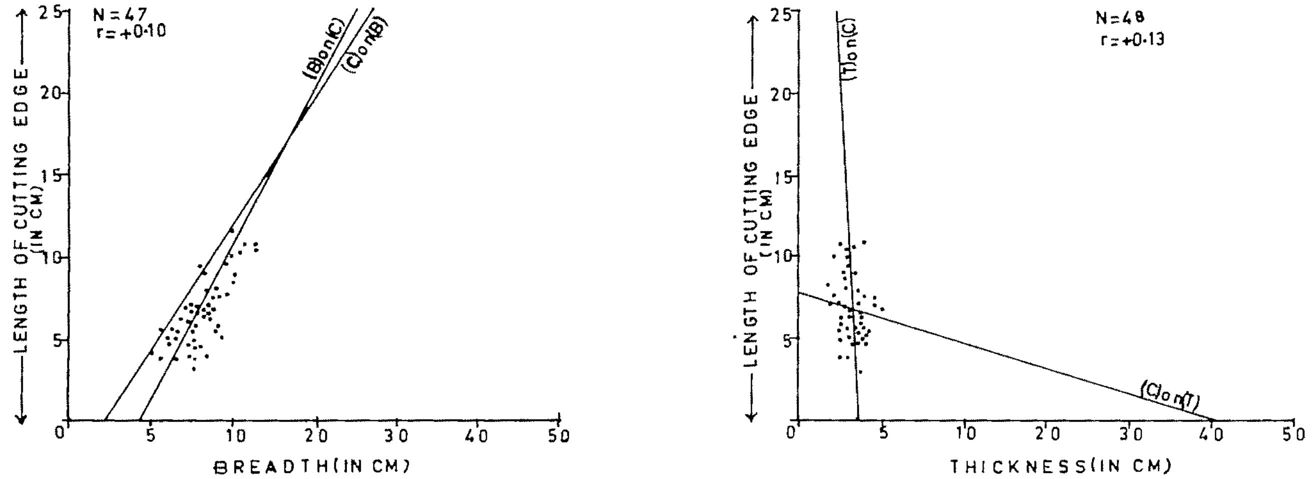
A: PLOT BETWEEN LENGTH AND BREADTH

D: PLOT BETWEEN BREADTH AND THICKNESS



B: PLOT BETWEEN LENGTH AND THICKNESS

E: PLOT BETWEEN BREADTH AND LENGTH OF CUTTING EDGE



C. PLOT BETWEEN LENGTH AND LENGTH OF CUTTING EDGE

F: PLOT BETWEEN THICKNESS AND LENGTH OF CUTTING EDGE

Fig. 6. Plots and Regression lines among Various Parameters of Cleavers from Gangapur Acheulian Industry

f) Normal Distribution Patterns (Fig.7)

i)In length, the Gangapur handaxes compare more closely with the Berach, Wagan and Paleru ones than with the Gambhiri and the Chirki handaxes.

ii)In breadth, the Gangapur handaxes more closely resemble the Paleru handaxes than the Berach, Gambhiri, Wagan and the Chirki ones.

iii)In thickness, they show greater similarity with the Berach and Paleru handaxes than with the Gambhiri, Wagan and Chirki handaxes.

g)Test Of Significance (t-test) (Table 6)

i)The Gangapur handaxes represent the same phase of the Acheulian techno-complex as the Berach handaxes in the case of the variables - length, breadth, over length and thickness over breadth ratios. They belong to the Acheulian techno - complex as represented by the Gambhiri and Wagan handaxes with regard to breadth, breadth over length and the thickness over breadth ratios. The same is also illustrated by the t-test in the case of breadth and thickness variables between the Gangapur and Paleru handaxes. On the other hand, all the variables except breadth, reveal that the Gangapur and the Chirki represent different phases of the Acheulian techno-complex.

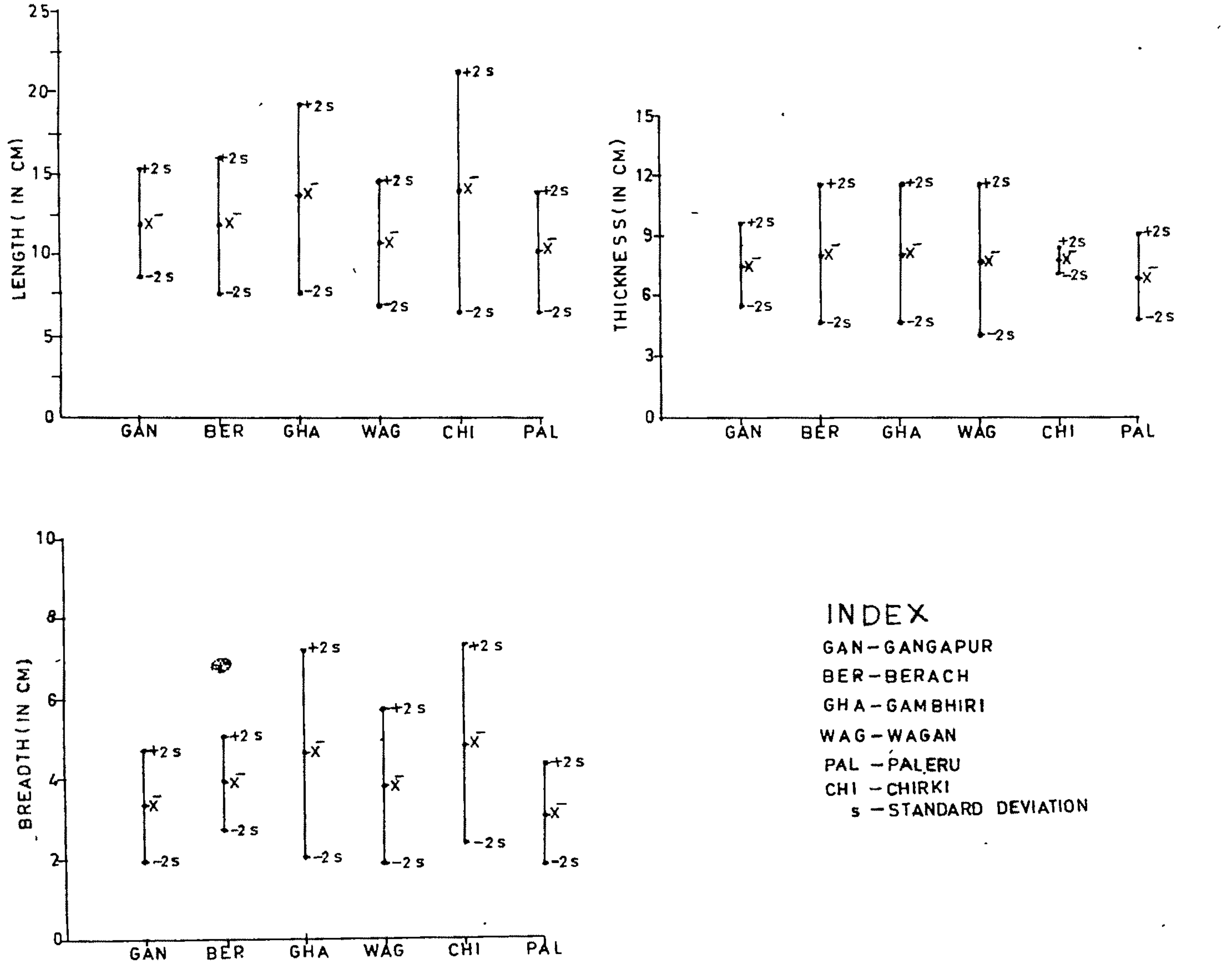


Fig. 7. Normal Distribution Pattern of Handaxes from Gangapur Acheulian Industry in Relation to Other Sites

Table 6:
t-test Analysis of Gangapur Assemblage in Relation to Other Sites

S.No.	Groups	Weight (W)		Length (L)		Breadth (B)		Thickness (T)		B/L		T/B		T/L	
		Cal.	Tab.	Cal.	Tab.	Cal.	Tab.	Cal.	Tab.	Cal.	Tab.	Cal.	Tab.	Cal.	Tab.
A:	HANDAXES														
1.	Gangapur and Berach(37)a	--	--	0.25	2.02	1.42	2.02	2.10	2.02	0.05	2.02	0.90	2.02	4.11	2.02
2.	Gangapur and Gambhiri(40)	--	--	2.20	2.02	1.48	2.02	4.06	2.02	2.05	2.02	0.90	2.02	6.47	2.02
3.	Gangapur and Wagan(50)	--	--	2.24	3.01	0.70	2.01	2.18	2.01	0.90	2.01	1.70	2.01	6.42	2.01
4.	Gangapur and Chirki(103)	3.94	1.98	3.44	1.98	0.80	1.98	3.10	1.98	--	--	--	--	--	--
5.	Gangapur and Paleru(187)	4.54	1.97	4.48	1.97	1.82	1.97	1.46	1.97	--	--	--	--	--	--
B:	CLEAVERS									Length of Cutting Edge					
1.	Gangapur and Mayurbhanj (113)	4.82	1.98	6.10	1.98	--	--	--	--	--	--	--	--	--	--
2.	Gangapur and Chirki(153)	6.02	1.97	6.91	1.97	2.20	1.97	12.77	1.97	0.96	1.97	--	--	--	--

(a - Degree of Freedom; Cal. - Calculated; Tab. - Tabulated) ii)t-test on cleavers of the Gangapur and the Chirki assemblages suggest that they represent different phases of the Acheulian techno-complex for all the variables, under consideration, except length of cutting edge. The same is also observed between the Gangapur and Mayurbhanj cleavers for weight and length of the cutting edge, of which the data are available (Ghosh and Ray 1964).

Conclusion

On considering, length, breadth and thickness parameters together, the Gangapur handaxes are found to be closest to the Paleru handaxes and distinctly different from the Chirki handaxes. Test of significance places the Gangapur handaxes in the same Acheulian techno-complex, as the Berach, Gambhiri, Wagan and Paleru ones. This coupled with broadness, refinement and the standardized nature of the handaxes for most of the parameters, brings out their advanced characters.

Similarly, the cleavers are found to be thinner, shorter and broader than those from the Chirki to Mayurbhanj. Most of the variable pairs, namely, length and breadth, length and thickness, breadth and thickness and breadth and length of cutting edge, show a high decree of association with each other. The refinement and shape indices demonstrate their refined and broad nature.

On the basis of their advanced characters, as revealed by the material data and various statistical tests, the handaxes and cleavers from the Gangapur site are placed in the late Acheulian phase

Acknowledgement

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Hunter-Gatherers in an Agrarian Setting : the Nineteenth Century Situation in the Ganga Plains

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Introduction

India has a tribal population of over forty million people comprising more than three hundred distinct communities which are officially designated as 'Scheduled Tribes' for favoured treatment in their educational and economic development These tribal communities are mainly confined to the hilly and forested regions of the country, like the Aravalli, Vindhya and Satpura Hills, Western and Eastern Ghats, Chota Nagpur Plateau, and northeast India outside the Bramhaputra Valley. As the topography of these regions makes them unsuitable for large-scale irrigation-based agriculture and for smooth transport and communication, they did not attract advanced agriculturists until the pressure of population in the more favourable alluvial plains forced farming groups to move into these less attractive environments in search of arable land. The tribal or aboriginal communities were therefore able to maintain their traditional modes of subsistence (hunting-gathering, fishing, shifting cultivation, and primitive plough cultivation), and their linguistic and cultural identities.

The establishment of British rule in the country initiated a new phase in the opening up of tribal habitats to outsiders. Systematic exploitation of forest and mineral resources, setting up of industries, development of rail and road communications, and rapid increase in human population in the plains subsequent to the improvement of law and order, expansion in medical facilities and general economic development, all contributed to the acceleration of this process. It has been further intensified by the planned development activities initiated after Independence. As a result tribal cultures have suffered much disintegration and impoverishment, and today there are hardly any areas in which these cultures survive in their pristine purity.

Against this background one would have thought that at least in the intensively cultivated and densely populated alluvial plains the aboriginal groups practising pre-agricultural or hunting-foraging mode of subsistence would have been completely assimilated into the new socio-cultural order. But in fact this has not always been the case. A good illustration of such a situation can be seen in the upper and middle Ganga Valley.

Geographical Background

The upper and middle Ganga valley (77° and 84° E : 25° and 30 N) is administratively equivalent to the present day State of Uttar Pradesh. In pre-Independence days this region was successively known as North-Western Provinces and Oudh, and United Provinces of Agra and Oudh. Geographically it forms a part of the vast Indo-Gangetic plain of north India which is the most fertile and densely populated region in the country. The elevation of the plain above sea level, in the region under consideration, ranges from 275 m in the west to 60 m in the east. The plain is drained by the Ganga and its numerous tributaries, some rising in the Himalayas to the north and others in the low hills of the peninsula to the south. The annual average rainfall ranges from around 800 mm in the west to around 1300 mm in the east. The natural vegetation cover is typical of the tropical dry deciduous woodlands. Steadily increasing population pressure and consequent human manipulation of the landscape over the last four thousand years, and particularly in the present century, have almost completely obliterated the primary vegetation cover; today only a few characteristic plant species survive in heavily degraded and isolated pockets. However, even as late as fifty years ago large tracts of woodland existed in the plains. Wildlife, specially blackbuck (*Antilope cervicapra*), chital (*Axis axis*), nilgai (*Boselaphus tragocamelus*), hyena (*Hyena hyena*), wolf (*Canis lupus*), fox (*Vulpes bengalensis*), jackal (*Canis lupus*) and porcupine (*Hystrix indica*), was also plentiful. Herds of blackbuck numbering several hundred individuals could be commonly seen in the vicinity of villages. However, conversion of woodlands into farmland and the easy availability of guns after Independence have almost completely decimated the blackbuck and chital, and considerably reduced the population of other species.

Occupational History

The occupational history of the region goes back to early Holocene when Mesolithic populations from the hilly country to the south colonised the southeastern part of the plain. Their archaeological remains have been found on over 150 sites in the districts of Allahabad, Pratapgarh, Sultanpur, Jaunpur and Varanasi in the form of stone, bone and antler tools, ornaments, animal remains, structural features and large cemeteries (Sharma 1973; Sharma *et al.* 1980). The present distribution of hunter-gatherers, however, shows that their ancestors had spread all over the Indo-Gangetic plain in the remote past. Colonisation of the plain by farming communities began in the second millennium B.C. and was accelerated by the introduction of iron technology at the beginning of the first millennium B.C. It is a remarkable phenomenon that, in spite of long and intensive occupation of this plain by agricultural and urban communities, peoples adapted to a forest environment and hunting-foraging way of life have persisted into modern times.

Sources of Information

Incidental references to some hunting-gathering groups exist in ancient and medieval literature but these have not yet been properly searched. The modern accounts of these peoples date from the nineteenth century, the earliest known to us being an article on the Badhiks and Thags published in 1818 (Shakespear 1818). It is, however, after 1860 that more accounts of these communities become available. These were written mainly by British administrators on the basis of information collected by themselves or through their subordinate British and Indian officials from members of the concerned communities. The main purpose behind collecting this information was to acquire comprehensive and accurate knowledge of the customs and habits of numerous Indian ethnic groups for their proper administration. This information is in the form of notes in decennial census reports, district gazetteers, articles in journals, and general ethnographic works (Cline 1867; Leeds 1867; William 1869; Elliot 1869; Sherring 1872; Nesfield 1883; Plowden 1883; Meade 1886, 1905; Bhattacharya 1896; Risley 1901; Kirkpatrick 1911, 1913; Rose 1911; Ibbetson 1916; Blunt 1931; Turner 1933; Bonnington 1935). Most of the earlier accounts were subsequently synthesized by William Crooke in a comprehensive four-volume survey published in 1896 under the title *Tribes and Castes of the North-Western Provences and Oudh.* This work, a veritable mine of anthropological information, gives brief ethnographic accounts, population figures, and distribution of all the communities of the upper and middle Ganga valley.

These accounts constitute our only source of information of these communities. Nesfield's article on the Kanjars published in 1883, for example, remains the most comprehensive chronicle of that community to this day. Although not always exhaustive and perhaps not wholly accurate by modern research standards, they nevertheless provide valuable insights into the dynamics of the cultural process by which the hunter-foragers managed to survive in a drastically altered natural and social environment by adding new economic pursuits to their traditional modes of adaptation and by forging links with peasant and urban societies.

The Ethnic Groups

Although previous writers had described or mentioned a number of ethnic groups of the upper and middle Ganga valley, Crooke (1896 I:cvlvii-clix) was the first to prepare a comprehensive list of them. He listed a total of 215 communities and classified them into 61 groups on the basis of their occupations. The two groups which are of interest to us in the present context are: (1) 'Hunters, Fowlers, etc.', and (2) 'Miscellaneous and Disreputable Livers'. Most of the communities in the group entitled 'Forest and Hill Tribes' also practise hunting-gathering in some degree but since they are confined mainly to the hilly tracts of Mirzapur district in the south and Himalayan hills in the north, they fall outside the scope of the present paper. A number of communities in several other groups also practise hunting-foraging and/or fishing, but they are not included in the present discussion as hunting-gathering plays only a minor role in their subsistence.

In Crooke's list the communities included among 'Hunters and Fowlers' are: Aheriya, Baheliya, Bandi, Bangali, Gandhila, Gidiya and Kanjar, and those comprising 'Miscellaneous and Disreputable Livers' and practising some degree of hunting-foraging are: Badhik, Bawariya, Bhantu, Habura, Sansiya and Siyarmar. While communities in both groups practise hunting-foraging, those in the second group had acquired considerable notoriety for their indulgence in crime and/or prostitution by their women. As no information is available on Gidiya and Siyarmar, these will not figure in the ensuing discussion.

To some extent the names of these communities, mostly derived from Sanskrit or Hindi (itself a language of Sanskrit origin) words and therefore obviously given by the Hindus, are themselves expressive of their economic status and overall lifestyle. Thus Aheriya is thought to be derived from Sanskrit 'Akhetika' meaning 'hunter', Badhik from Sanskrit 'Vadhaka' meaning a killer or murderer, Baheliya from Sanskrit 'Vyadha' meaning 'one who pierces or wounds', 'a hunter', Kanjar from Sanskrit 'Kanan Char', 'wanderer in the jungle', and Gandhila from 'Gandh', meaning 'fetid' or 'malodorous'. The name Bawariya or Baori is believed to be derived from *Bawar* meaning a noose or snare which they use for trapping animals (Ibbetson 1916) or from *Banwar* a creeper from which they make the noose or snare (Crooke 1896 I:228). The Bawariyas of western U.P. claim that the Gurjars call them Gidiyas and the Jats call them Baoris. Gidiya, according to Crooke, is merely a local name of the Bawariyas.

Because there is considerable uniformity in the lifestyles of all these communities, most writers believe that not all of them may be distinct ethnic groups; instead they are more likely to be offshoots of one or more parental stocks who acquired separate names and identities by fission and geographical and cultural isolation. The Badhiks, for example, are believed by Crooke to be closely allied to the Bawariyas and Baheliyas, are of mixed origin, and on the same grade as the Kanjars, Sansiyas, and similar vagrants. The Aheriyas, on the other hand, consider themselves to be identical with the Baheliyas, and both trace their ancestry to the poet-sage Valmiki. The Bangalis, according to Crooke, even though they disclaim any direct connection with Nats, Kanjars and similar vagrants, are obviously closely related to the latter. The Aheriyas of Aligarh admit that in former times, owing to a scarcity of women in the tribe, they used to introduce girls of other castes. This, they say, they have ceased to do in recent years, since the number of their females increased. In Aligarh they are known by different names, viz. Aheriya, Bhil or Karol. The Beriyas, in the opinion of Crooke (1896 I: 242-249), are closely allied with Sansiyas, Kanjars, Haburas, Bhantus, etc. They are a mixed race and many outcasts join them. The Haburas are very closely connected with Sansiyas and Bhantus and they have only recently become an endogamous group. The Sansiya, according to Crooke, is a near kinsman of the other degraded wandering races who occupy the same part of the country, such as the Kanjars, Beriyas, Haburas and Bhantus. Bhantus, again according to Crooke, are merely one branch of the Sansiya tribe, known elsewhere as Beriya, Habura or Kanjar. Some connect the derivation of the word with Bhat (bard), as some Sansiyas act as bards or genealogists to some Rajputs and Jats. The Bhantus of Agra, Bareilly, Badaun, Moradabad, Ghazipur, Kheri and Sultanpur are said to follow the customs of the kindred tribes of Beriya, Habura and Sansiya.

Population And Distribution (Figs. 1-2)

The communities differ markedly in their numbers and geographical distribution. We have used data from 1891 and 1971 censuses to highlight the changes that have taken place in these two parameters.

According to the 1891 census the largest population (33,754) was of the Baheliyas who were found in forty-three districts of the State, covering nearly the entire plain, though their concentration was more in the central and eastern districts. Numerically, the next were the Aheriya (19,768) who were found only in sixteen, mainly western and central, districts. The third largest community were the Kanjars who, though numbering only 17,865, were the most ubiquitous, occurring in all the forty-seven plains districts, though relatively more numerous in the western and central parts. Of them Nesfield (1883:369) says: 'There is scarcely a district in Upper India, in which small encampments of Kanjars cannot be seen at times, either in solitary jungle tracts which are favourable for game and secrecy, or in the outskirts of villages, wherever it may be convenient to them to halt and sell their wares'. The Beriyas, with a population of 15,313, were found in 36 districts, the major concentration being in central and eastern districts. Next in sequence were the Sansiyas who numbered 4,290 persons and were spread over eighteen western and central districts, the majority being concentrated in Saharanpur and Meerut. The Bawariyas and the Haburas had fairly similar populations, numbering 2,729 and 2,596 persons respectively. The former were found in six widely separated districts and the latter in seventeen western and central districts, being totally absent east and south of Lucknow. The Bangalis numbered only 1,350 and occurred in twenty-six districts from Dehradun in the northwest to Gorakhpur in the southeast. The Bhantus, Bandis, Gandhilas, Badhiks and Gidiyas had populations of less than 400 individuals each, and therefore had restricted distributions. The Bhantus numbering 372 were confined to seven districts in the west and east, being totally absent in the centre of the State. The Gandhilas, with a population of 134, were confined to the two districts of Saharanpur and Muzaffarnagar. The Badhiks, numbering 126, occurred in Mathura and Pilibhit districts, with one individual recorded in Gorakhpur.

A comparison with the population figures and distribution of the 1971 census shows that there have been very uneven increases in population over the period of eighty years While in some cases the increase has been less than fifty per cent, in others it has been 2000 per cent or even more. Thus, for example, the population of the Baheliyas rose from 33,754 to 41,454, that is by 22.8 %. Similarly, the population of the Haburas rose from 2,596 to 3,389, that is by 30 %, and that of the Sansiyas from 4,290 to 5,626, that is by 31 %. Again, the increase in the case of the Bawariyas was from 2,729 to 3,757, that is 37.7 %. In the case of the Kanjars the increase was slightly higher, from 17,865 to 44,176, that is 147 %. On the other hand, the increases in the case of the Bangalis, Bhantus and Badhiks were truly dramatic. The population of the Bangalis rose from 1,350 to 26,152, that is by 1837 %,

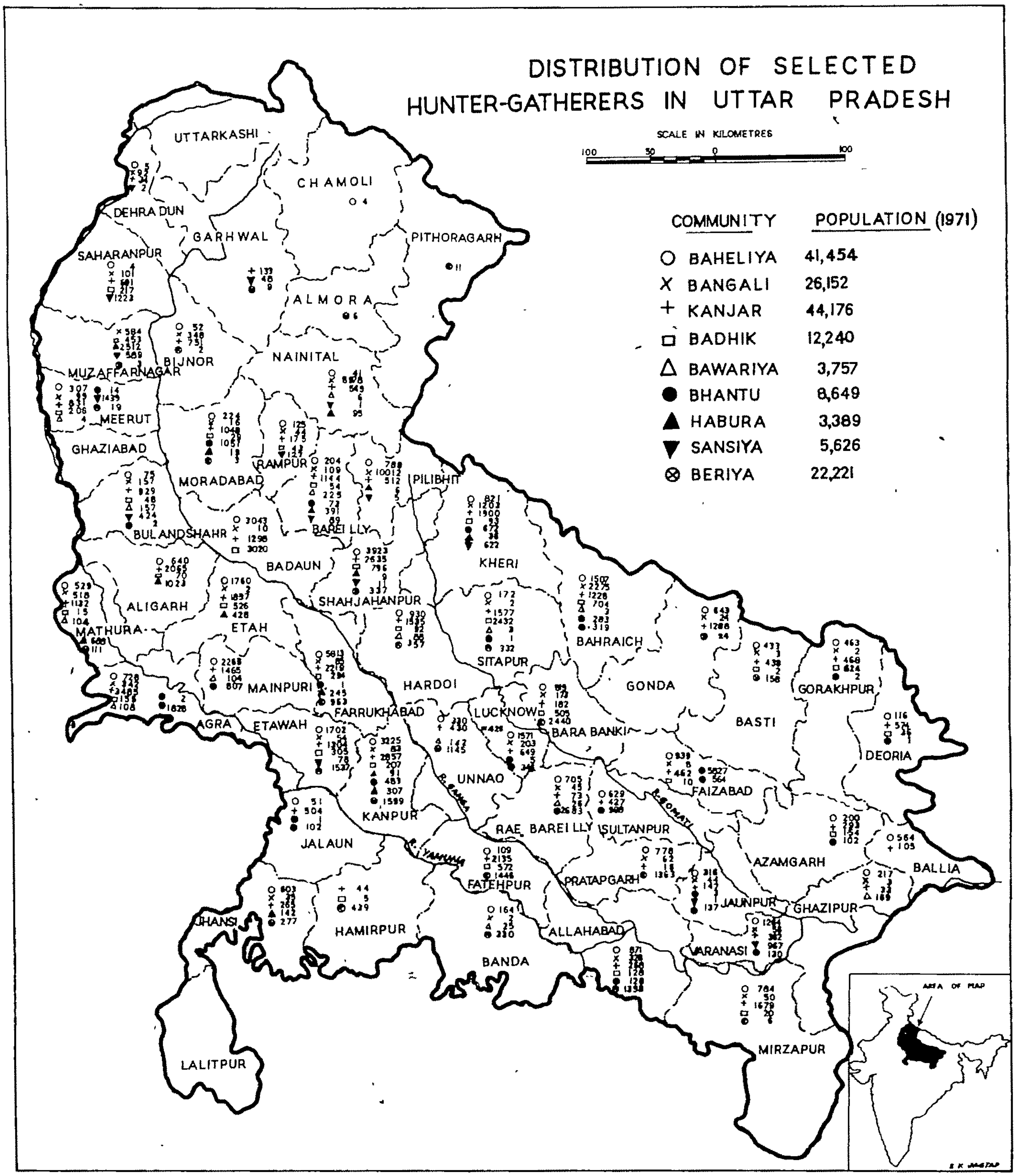

Fig. 1. Distribution of Selected Hunter-Gatherers in Uttar Pradesh.

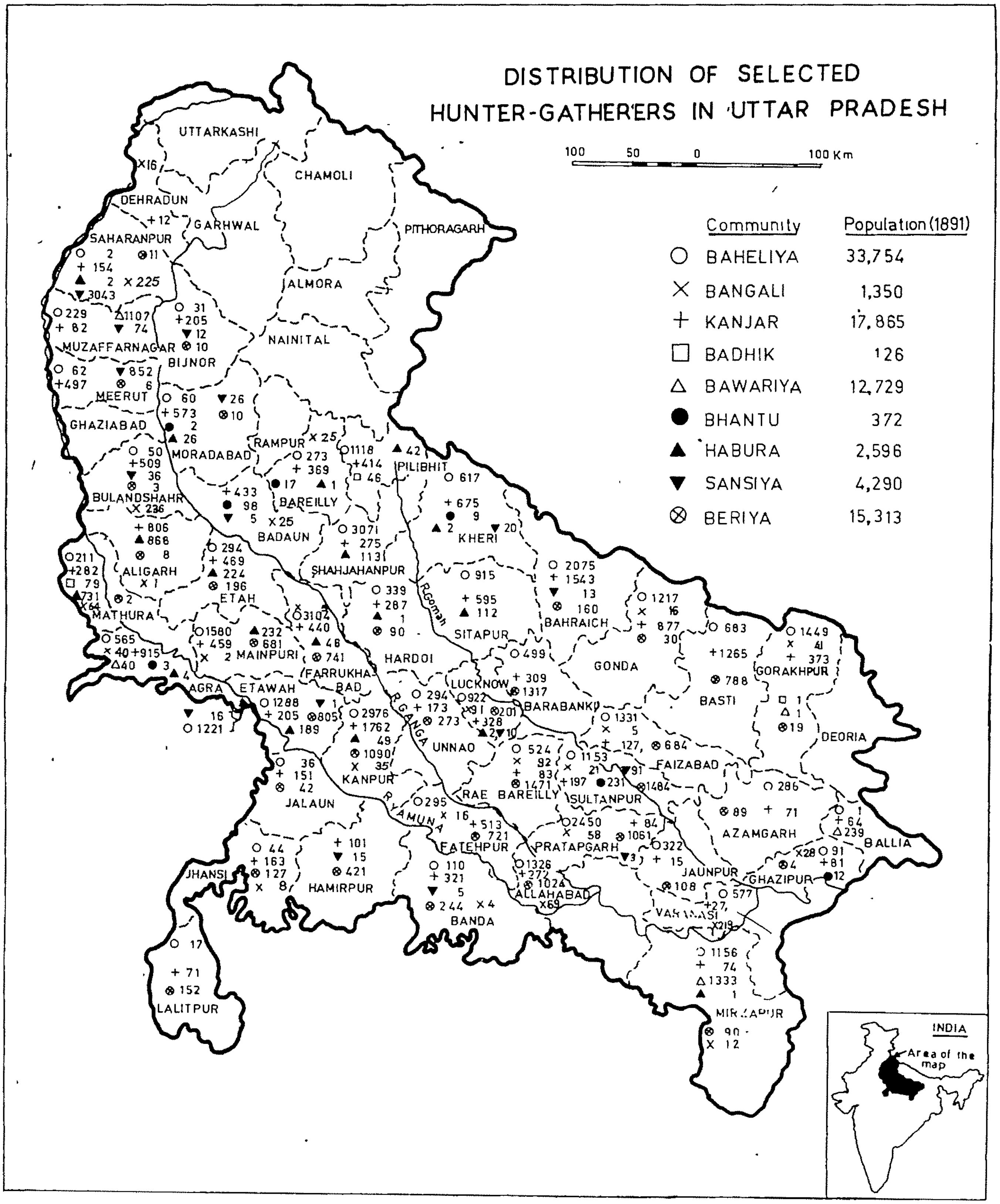

Fig.2. Distribution of Selected Hunter-Gatherers in Uttar Pradesh.

that of the Bhantus from just 372 to 8,649, that is by 2225 %, and that of the Badhiks from only 126 to 12,240, that is by 9614 %. It is obvious that these very uneven increases have something to do with the methods of enumeration adopted by census workers.

The changes in the distribution pattern of the various communities have also been noteworthy though not as dramatic as those in the case of population. Only in the case of the Kanjars and the Beriyas there was no change at all; they continued to inhabit the 47 and 36 districts respectively in which they were present in 1891. The distribution of some communities increased, for example, of the Baheliyas from 43 to 47 districts, of the Bangalis from 26 to 36 districts, of the Badhiks from 3 to 31 districts, of the Bawariyas from 6 to 16 districts, and of the Bhantus from 7 to 17 districts. There was a slight decline in the distribution area of two communities. The Sansiyas shrank from 18 to 15 districts, and the Haburas from 17 to 12 districts. The exact cause or causes of these changes can be ascertained only after a scrutiny of the data from intervening censuses and a study of the recent history of these communities.

Settlement Pattern

All these communities are described as vagrant and living their life in continuously shifting camps. Sections of some of them, however, appear to have settled temporarily or even permanently in the vicinity of villages and towns.

The Aheriyas, according to Sherring (1872 I:405), are a tribe of wild and uncivilized people, exceedingly poor, and almost destitute of clothing. According to Crooke, the Bangalis wander all over the Upper Duab and Punjab and the Native States, and the Gandhilas wander about with little huts made of reed (*sirki*), seldom stay more than a few days in the same place, and call themselves indigenous to the Upper Ganges-Jumna Duab. Lieut. R.C.Temple (1882:42) says about the Gandhilas that 'they are usually described in the courts as 'homeless sweepers'. They are Musalmans of a very low order of intelligence, and in appearance more like beasts than men'. The Bhantus lead a nomadic life keeping as far as possible away from villages when they camp; men from different gangs would however combine in the event of a raiding expedition (Bonnington 1935:37). The Beriyas also are vagrant, and those of them whose camps (*gol*) frequent the area around Nohkhera in Etah District meet at that place during the rainy season, and hold tribal councils at which marriages and all matters affecting the caste are settled. The vagrant branch of the Sansiya tribe according to Crooke live under portable reed mats (*sirki*). They are very fond of dogs and keep a number of them to guard the camp. The camp is usually pitched on one of the high sandy ridges which are such a prominent feature in the landscape of the Upper Duab. They keep numerous bullocks and donkeys which they use for transporting their huts and goods, as well as cows and goats for milk.

In the case of Kanjars, Nesfield (1883:369) says 'All true Kanjars are addicted to a roving life; and if they halt for a time near some town or village, they put up their temporary sheds made with poles and matting, in a grove at some distance apart from the abodes of the settled inhabitants... Their natural home is the forest'. Some of them seldom or never leave the forest. The close association of the Kanjars with the forest is also exemplified by the custom of the girl's father giving away to his son-in-law as dowry 'a patch of forest assumed to be his own, which becomes thenceforth the property of the bridegroom, so long as the encampment remains near this place, or whenever it may return to it. No one without the bridegroom's consent will be authorised to use this piece of forest either for hunting or trapping, or for digging out the roots of *khaskhas*, or for gathering wild honey, or collecting medicinal herbs' (Nesfield 1883:382-83). The practice of disposing of the dead body by exposure in the forest among several communities, like Kanjars and Baheliyas, also shows that they preferred to live in the forest.

The exact size of the nomadic groups is not always mentioned but it appears to have been small. Kanjars, for example, according to Nesfield (1883:370), 'are seldom or never seen in groups of more than 20 or 40 persons of all ages at a time, and the number is sometimes less. These little groups may unite sometimes for special and temporary objects. But large groups are never permanently formed... there are some groups or clans, which make a habit of keeping within easy reach, while others seldom or never leave the forest. But even among the former, it is not merely the proximity of settled communities, which prevents the formation of larger groups. For even in the wider forest tracts, where there is ample space and no impediment from higher races, the same law of petty non-associative hordes prevails; and it would be a rare thing to find an encampment of more than, or even as many as, 50 persons'. In the case of the Bhantus, a gang is said to be composed of a dozen families.

Subsistence

Hunting, Trapping and Fishing

All these groups lived in varying degrees by hunting and foraging, and most of them had few inhibitions about the choice of animal foods they ate, the only exception being beef which all of them avoided obviously in deference to the sentiments of their Hindu neighbours. The Aheriyas, according to Sherring (1872 I:405), catch snakes, roast, and eat them This in fact is the chief employment of some of them. They are also to some extent fowlers. In Punjab they are said to catch and eat all kinds of wild animals. The occupation of the Baheliyas is described as hunting, bird trapping and collection of jungle produce. Bird catchers among them were known as 'Miskar', said to be a corruption of 'Mir Shikar', meaning 'head huntsman' or 'Maskar', meaning 'eater of meat'. One endogamous group among them is named Chiriyamar (bird killers), and the speciality of another group, named Karaul, is said to be stalking animals under cover of a tame ox used as a decoy. They have the reputation of being skilled *shikaris* (hunters) and game trackers. They eat the flesh of fowls, goat, deer and sheep, but not pork or beef, and they will not kill a cow, monkey and squirrel. They drink liquor freely. The Bandis, like the Baheliyas, are essentially bird catchers. The Bangalis eat the flesh of cloven or uncloven footed animals, fowls, all kinds of fish, and crocodiles. The Gandhilas eat squirrels, quails, tortoises, dogs, any kind of carrion, including putrid flesh, and vermin of all kinds which they catch.

The Kanjars, according to Nesfield, subsist by hunting jackals, foxes, wolves, hares, trapping birds and squirrels, and digging out snakes, mongooses, bandicoots, field rats, lizards, turtles and turtle eggs, and any other kind of vermin that chance may throw their way; all of which they eat indiscriminately. Whatever a Kanjar kills, from a wolf to a reptile, he eats; and most of what he finds dead, he eats also. He does not eat dogs nor monkeys.

The Badhiks eat game and vermin, such as foxes, jackals, and lizards. They believe that the use of jackal meat fortified them against the inclemencies of winter. According to Sherring the Badhiks in some districts of U.P. are known as Khors or Siyar-Marwas (jackal-killers), on account of their habit of eating the flesh of the jackal. The Bawariyas, like the Baheliyas and the Bandis, mainly live by catching birds of all kinds. They eat almost any kind of meat except beef, and indulge freely in liquor. For Bhantus, according to Wahi (1949), eating of certain quadrupeds like cow and deer is taboo. He does not eat the creatures which live in water, like fish, turtle, etc. as they are considered dirty. The Haburas hunt and trap *goh* or iguana, *sanda* or monitor lizard, hedgehog, jackal, wild cat, buffalo, deer, fowls, tortoise, fish, crocodile, and other vermin. They eat all these and pork but not cow and donkey. The Beriyas, according to Crooke (1896 I:243), eat whatever they can get, whether it be a rotten jackal or a piece of beef or mutton. They are seldom without large supplies of game and flesh of wild animals, of all kinds. A variety of birds they keep dried for medical purposes; mongooses, squirrels and flying foxes they eat with avidity as articles of luxury. Liquors and intoxicating drugs are indulged in to a large extent, and chief of clans assume the title of Bhangi or drinkers of hemp (*bhang*) as a mark of honour. In the case of the Sansiyas the available accounts are silent regarding their hunting practices. But as they too are a nomadic people, camping in the forest and on sandy ridges, and are described as near kinsmen of the other wandering groups, it is almost certain that they too practise hunting in some measure.

Gathering

All these communities also exploited wild plant foods for their subsistence though information on this aspect of their economy is not as plentiful as on hunting. The Aheriyas collect gum of the *dhak* or (*palas*) (*Butea frondosa*) and acacia trees, and honey. Bawariya women sell the roots and herbs, etc. which they collect in the jungles. The Kanjars gather 'such roots and vegetable products as require no cultivation, and extract juice from the palm tree, which after it has become fermented, is a favourite beverage of almost all the wandering and low caste tribes of India' (Nesfield 1883: 369) They were, and are to this day, expert honey collectors.

Technology And Techniques of Hunting

Not much information is available in this regard except in the case of the Kanjars. The major tool and weapon of the Kanjars is the *khanti*. The name is probably derived from the Sanskrit *khan* meaning to dig or make a hole. The tool consists of a 1 m long wooden handle and an iron blade, about 30 cm long and sharpened into a curved point something like the blade of a knife and hafted at one end of the handle. The iron blade is procured by Kanjars from ironsmiths, and the handle is made by themselves. The implement serves as a dagger or short spear for killing wolves and jackals; as a tool for carving a secret entrance through the clay-wall of a villager's hut, where a burglary is meditated; as a spade or hoe for digging snakes, field rats, lizards, etc. out of their holes; for digging edible roots, and roots of *khaskhas* grass out of the earth, and as a hatchet for chopping wood. The *Khanti* or short spear is not merely used in close combat, but is thrown with almost unerring effect against wolves or jackals as they run.

In the use of their simple weapons, the Kanjars display extraordinary skill. The weapon with which they kill little birds is nothing but a pole pointed with a thin sharp spike of iron. The man lies motionless on a patch of ground, which he has first sprinkled with grain; and as the birds come hopping around him to pick up the grain, he fascinates one of them with the pole by giving it a serpent-like motion, and then spikes it through the body. Kanjars seldom or never use the bow and arrow; but they use the pellet bow, which requires much greater skill. The pellet is nothing but a little clay marble dried in the sun. With this they frequently shoot flying birds. For trapping a wolf in its lair they place a net and a light at one end of the hole, and commence digging at the other end. The wolf attracted by the light runs into the net, and the Kanjar then batters its head with a club and kills it.

The Baheliyas have a most ingenious mode of trapping birds with a series of thin bamboos, like a fishing rod, on which bird-lime (*lasa*) is smeared. This they push with great skill through the branches and leaves where a bird is sitting, and entangle his wings and feathers. According to Sherring (1872:352), the Baheliya while catching birds is seated on the ground with a long pole in his hand, at one end of which is a sharp spike. He slowly introduces the pole among a number of birds carelessly hopping about picking up grain, giving it a zig-zag direction and imitating as much as possible the movement of snake. Having brought the point near one of the birds, which is fascinated by its stealthy approach, he suddenly jerks it into its breast, and then drawing it to him, releases the poor palpitating creature, putting it away in his bag, and recommences the same operation. The Baheliyas also catch birds with a kind of lime taken from the *Maddar* tree, by means of a long pole, as in the former instance. The viscous substance at the end of the pole, on touching the bird, sticks to it, and it is caught. As for the use of bow and arrows, it is mentioned only in the case of the Beriyas (Crooke 1896 I:243). They are also said to be great adepts in laying snares and traps.

Other Occupations

All these communities also engage in collecting a wide range of forest produce which they use to make a variety of articles for the needs of the village and town people. These are either bartered or sold. The Aheriyas collect leaves of *palas* for making platters which they sell to Hindus. They also collect reeds for making baskets, etc. The Baheliyas too collected jungle produce, made ropes, and were employed as watchmen and in other services. In Mirzapur some of them worked in lac factories, and a few cultivated as nonoccupancy tenants. The Gandhilas collect grass and straw for making baskets and sieves, catch quails, clean and sharpen knives and swords, cut wood, and generally do odd jobs (Rose 1919 II:278). Bawariya women are also experts in making patchwork quilts which they sell. The Beriya male practises 'everything that enables him to pass an easy life without submitting to any law of civilized government or the amenities of social life. His women deal with palmistry, cupping with buffalo horns, administering moxas and drugs for spleen and rheumatism. They are also tattooers. At home the women make mats of palm leaves, while the husbands cook' (Crooke 1896 I:243).

The Kanjars practise a variety of crafts, the products of which they sell to village and town people in exchange for grain, milk, pigs, etc. They make mats of *sirki* or *munj* (*Saccrum munja*) reeds, baskets of cane, fans of palm leaves and rattles of plaited straw, the last sold to Hindu children as toys. From the stalks of *munj* grass and from the roots of *palas* tree they make ropes. They prepare the skins for drums which are sold to Hindu musicians. They make plates and cups of *palas* leaves for selling to sweetmeat makers. The mats of *sirki* reeds with which they cover their own temporary sheds, are largely used by cart drivers to protect their goods and themselves against rain. The toddy or juice of the palm tree which they extract and ferment, partly for their own use, finds a ready sale among low caste Hindus. Kanjars are the chief stone-cutters in north India, specially in the manufacture of grinding stone which is used in every rural home. They gather the white wool-like fibre which grows in the pods of the *salmali* or silk cotton tree and twist it into thread for the use of weavers. They have an almost complete monopoly in the manufacture of brushes for cleaning cotton yarn and in the collection and sale of ***khaskhas*** grass for making screens that are widely used as room coolers during summer months (Nesfield 1883).

The eastern Bawanyas are now settled and cultivate land as tenants. The Aheriyas in some places, as in the Aligarh district, are also beginning to cultivate land and are becoming more civilized day by day. Besides, the Bangalis, Kanjars and Beriyas all acted as rustic surgeons for bleeding and cupping. The Gandhilas and the Beriyas engage their women in prostitution, and both beg and eat the leavings of upper caste Hindus. Bandis are drummers and bird-catchers in the Himalayan Tarai. Their chief business is catching birds for sale. They also make a living by catching birds and bringing them into cities where pious people, such as Jain Baniyas, pay them to release a bird as an act of piety or as a charm to take away disease from a sick person. In their habits and occupation they resemble the Baheliyas. Bawariyas who are also bird-catchers sell the birds that are eatable; others they take to the houses of rich Jain merchants and make an income by releasing them from their cages.

Crime

Detailed information is available about the criminal activities of these communities. Except the Baheliyas, Bandis and Bangalis all the other groups indulged in crime though the degree of their addiction varied.

The Aheriyas, according to Crooke, chiefly carry on the business of burglary and highway robbery, and they are about the most active and determined criminals in the Province. Their children learn to steal at an early age and by about sixteen years are ready to join in the expeditions. Gangs consist of from ten to twenty people though the number may occasionally go up to forty. Their leaders (Jamadars) are elected for their skill, intelligence, and daring. When questioned about their identity while on a raiding expedition they generally give the name of a respectable community. They avoid putting up at *sarais* (inns) and generally encamp 100 or 200 paces from the high road to watch travellers, carts, and vans passing. They all carry bludgeons, but one or two in the gang may also carry a sword. They commence by pelting the guards of the carts or camels with pieces of limestone (*kankar*) or stone. This generally causes them to flee; but, if not, they assemble and threaten them with their bludgeons. They claim that even though they were always thieves by profession, they did not take to highway robbery till the great famine of 1833, and they were taught this easy mode of living by the Baheliyas.

The Gandhilas, according to Major Temple, are inveterate thieves, especially of dogs, which they eat. The Kanjars are essentially hunters rather than criminals, but a few of them are known to engage in robberies. According to Nesfield, many of the *dakaits*, or gang-robbers, who infest the public highways at night, are Kanjars; and in the pursuit of this calling they are sometimes associated with evil-doers from among the Hindu community.

The Badhiks were known to be notorious *dakaits* (highway robbers). One of their specialities used to be disguising themselves as Brahmans and Bairagis (mendicants) and associating with pilgrims returning from the Ganges, for whom they used to perform mock religious ceremonies, and then stupefy them with *datura* (thorn apple) and rob them. They were in the habit of making plundering expeditions. Sherring (1872:390) describes them as a caste of professional robbers and assassins.

Bawariyas, according to Crooke, were traditional killers and plunderers for the princes, and they never had occasion to labour at tillage. The western Bawariyas are best known as a criminal tribe. When they go on their predatory excursions which extend over a large part of Northern India, they change their appearance by putting on the dress of faqir. The only way of finding them out is by a peculiar necklace of small wooden beads, which they all wear, and by a kind of gold pin which they wear fixed to their front teeth. The peculiarity about their thieving is that when they enter a house they take with them some dry grain, which they throw about in the dark, so as to be able by the rattle to ascertain the position of brass or other metal objects.

The Bhantus have been known to travel very great distances in disguise for the purpose of committing thefts, robberies and dacoities. The gang usually consists of some 30 to 40 people. Often cruel and violent methods were adopted to compel the victims to reveal the hidden places of their treasure, such as forcing women to sit on burning charcoal, or raping, etc. The traditional weapon of attack was a short hard stick, thrown with tremendous force. In more recent years, however, guns have been adopted. Many of their gangs are led by women. It is also apparently legitimate for a Bhantu woman to use her womanly wiles in the advancement of the tribe's criminal activities (Bonnington 1935). According to Wahi (1949), for the Bhantu committing a crime for the tribe is like a religious injunction and hence a social virtue. The more efficient a Bhantu is in committing crime, the higher is his status in his society. The young girls refuse to accept as bridegrooms any but the adept criminals. Children are trained to commit crimes. They are taught everything regarding disguise, use of code words, hiding small ornaments, rings etc. in their throats.

In the case of the Beriya, his women loaf about villages and procure information about valuable property for their male relations. The males will steal crops from fields and property from the houses of the villagers. They have also been known to commit more serious crimes and attack camel carts and wedding parties at night (Crooke 1896 I:247).

The vagrant branch of Haburas are said to be the pest of the neighbourhoods and are continually robbing standing crops, attacking carts and passengers along the roads, committing robberies and even *dakaities*. The boys are trained at first on field robbery, and are then taken out on excursions for the purpose of burglary. When they go to rob fields, the gang consists of not less than twenty people, and for the purpose of burglary eight or nine together. They never carry any weapons but bludgeons; they seldom use violence (Crooke 1896 II:479-80).

The Sansiyas are one of the most audacious criminal tribes in the Province. In the Upper Duab they had no other means of livelihood except *dakaiti*, road robbery, thefts from vehicles, barns, and from persons sleeping in the fields In the course of their operations, unlike the Haburas or Beriyas, they were always ready to commit violence, and have been known to cause serious bodily injury and even death with the heavy bludgeons which in recent years they had substituted for short clubs. During highway robbery they suddenly attack passengers or the drivers of vehicles with showers of stones. If this failed to compel them to abandon their property, they fall on them with their bludgeons. Another device was to disguise themselves as constables, and in the course of a mock search to rob travellers. They do not stay at *sarais*, but encamp outside a village or town, and being well dressed, pretend to be Banjaras (merchants). In Aligarh they are divided into seven gangs (*gol*), of which leaders of five were women, and two were led by men. The reason that women so often command the gangs is because so many of the males are habitually in jail (Crooke 1896 IV:283-84).

Attitude of the Government

Until the advent of the British the tribal societies enjoyed relative freedom from interference in their affairs by the ruling elite. During the decay of the Mughal empire in the eighteenth and early nineteenth centuries there was a general decline of law and order. Gangs of Thugs, Pindarees and other criminal groups roamed around freely plundering travellers and traders. Some of these hunter-gatherer groups living in this environment of lawlessness and probably already accustomed to crime took to it on a larger scale. When the British established their rule in the Ganga plains, they took various measures to suppress these criminal groups. As a part of this process in 1871 the government passed the Criminal Tribes Act. Under this Act the government could declare any tribe or group as a Criminal Tribe provided adequate evidence existed for doing so. Steps were also taken for settling and keeping a surveillance on the vagrant tribes. This Act was amended several times (1897, 1911, 1923,and 1924) to remove the various lacunae and make it more effective. Under this Act provisions were made, among other things, for (i) local governments to declare a tribe as a Criminal Tribe without requiring its settlements or the provision of the means of living; (ii) registration of the members of the tribes and taking of their finger impressions for observation and supervision; (iii) separation of the children of habitual offenders from their parents and putting them in reformatory 'settlements'; and (iv) restricting the more criminally minded members of the notified tribe to any specified area or interning them in settlements to be specially established for them. Under this Act a total of 115 communities all over the country were declared as Criminal Tribes. Among the twelve communities discussed in this paper all except Bandi were included in this category

In pursuance of this policy the British government established a number of settlements for criminal tribes. A strict watch was kept on the movements of the inmates of the settlements. and jobs were provided to them to wean them away from crime. This policy succeeded in large measure in reforming the criminal groups

The Indian government soon after Independence in 1947 felt that it was unfair to condemn whole communities or groups as Criminal Tribes for crimes committed only by a section of them Accordingly the government appointed a committee in 1949 to enquire into the working of the Criminal Tribes Act, 1924, and to make recommendations for its modification or repeal. 'The Criminal Tribes Act Enquiry Committee' in its report recommended the repeal of the Act. The Indian Parliament passed the Criminal Tribes Law (Repeal) Act, 1952 By this law all the Criminal Tribes were declared denotified.

In the Constitution of India which came into effect in 1950 special provisions were made for the speedy development of the untouchable castes of the Hindu society and the tribal peoples. These two classes were categorised as Scheduled Castes and Scheduled Tribes, respectively. Their names were specified by Presidential Orders first issued in 1950 and amended on subsequent occasions. In these orders none of the groups discussed in this paper were included among the Scheduled Tribes. However, except Aheriya, Bandi and Gandhila all of them were included among the Scheduled Castes. From 1951 onwards the Census Department stopped enumerating communities on caste basis. However, the population of the Scheduled Castes and Scheduled Tribes continued to be separately enumerated. As a result we do not have data even on the population and distribution of those denotified communities which were not included under Scheduled Castes. But for a few exceptions (Gautam 1983; Majumdar 1941-42, 1944, 1947; Mahalanobis *et al* 1946; Wahi 1949) little research has been conducted in recent decades on the condition of the various denotified communities, and so we have virtually no information on the present condition of these hunter-gatherer or criminal tribes.

Interaction with the Larger Society

There is no evidence to suggest that any of these hunter-gatherer groups have entered the Ganga plains in historically recorded times, i.e. during the last three thousand years or so. On the contrary, there are ample references in the early Sanskrit literature to show that the Aryan colonisers of the plains in the second and first millennia B C. encountered indigenous dark-coloured and snub-nosed populations whom they contemptuously called *dasa* or *dasyu* (slaves). On the other hand, the extensive presence of Mesolithic populations in the southeastern part of the plain would suggest that the living hunter-gatherers are descendants of those populations. Agriculture-based settled societies began to appear in the plains at the beginning of the second millennium B.C., and colonisation of the plain by them was intensified after the introduction of iron technology at the beginning of the first millennium B.C. The social ideology of the economically and politically dominant Aryan society was shaped by Brahmanism, the forerunner of present-day Hinduism. From the middle of the first millennium B C. this society became increasingly organised into the caste system. This system was hierarchical, and the place of every community in it was determined by its occupation, food habits, political power, and the degree to which it followed Brahmanical rituals. No social group which had any economic or political interaction with Aryan society could remain unaffected by the caste system.

The hunter-gatherers living in the Ganga plains shared their environment with the Aryan peoples living in villages and towns. Being economically, technologically and politically weaker than the Aryan colonisers they could be easily subjugated by the latter. Their labour was useful for expanding agriculture and settlement, and their traditional craft skills in rope making, weaving, etc. could be utilized for producing articles required by the peasantry. Thus many autochthonous peoples were slowly drawn into the Aryan caste-based society. The place they got in the hierarchical system depended on their qualifications stated above. Those who continued to live in the forest away from permanent settlements managed to retain their economic, social, religious and political freedom. But as population grew and more and more forest was cleared, the habitat of the hunter-gatherers shrank, and all of them were obliged to come into contact with the dominant Aryan people. This situation was already achieved by early nineteenth century when the British conquered the Ganga plains, and probably even earlier.

This steadily increasing contact between the Aryan settlers and the largely nomadic indigenous populations was bound to influence the social and religious ideologies of both the societies. And this is what we find when we examine their institutions.

The hunter-gatherers had their distinctive religious and social beliefs and practices. While they have retained these, they have also adopted some of the Hindu deities and rituals. More than that, even while retaining their identity as tribes they have not remained unaffected by the philosophy of caste. They have accepted, even if reluctantly, their own low position in relation to upper Hindu castes, and imbibed the

Hindu attitudes towards various castes in their dealings with them. On the other hand, large sections of the hunter-gatherers have been fully incorporated into the caste system and have totally lost their identity as distinct non-Hindu indigenous peoples. The Hindu society, in turn, has absorbed some of the religious beliefs and practices of the hunter-gatherers, specially at the level of the lower castes, but also to some extent at the level of upper castes as well. We shall try to illustrate these changes and the processes underlying them in the following discussion.

The religion of the indigenous peoples as we know it from the ethnographic accounts is mainly centred around the worship of ancestors and local gods and goddesses. Nesfield's description of the religion of the Kanjars as being 'without idols, without temples, and without a priesthood' is in its essence true of the religion of all the other communities discussed in this paper. The aborigines live in constant dread of the evil spirits, the souls of the departed, who are said to enter into the bodies of the living as a punishment for past misdeeds or neglect of burial rites, and to produce most of the ills. All deaths, but those caused by natural decay or by violence, are ascribed to the agency of evil spirits. The ancestors as also the other deities are periodically propitiated by the offer of animal sacrifices to prevent them from causing any harm in the form of injury, sickness, and death (Nesfield 1883).

The special deity of the Badhiks, Bawariyas and Bhantus is the goddess Kali, to whom they offer goats. Aheriyas and Sansiyas worship Devi (mother goddess). The goddesses of the Beriyas are Devi, Kali, and Jwalamukhi. In Bijnor the Beriyas usually worship Kali Bhawani. In Mathura they have a local goddess, Kela Devi, to whom on special occasions they sacrifice a buffalo or goat in her honour. The Kanjars worship at least three goddesses. Among the Aheriyas Mata (mother), the small pox goddess, and Masani, the spirit of the burning ground are worshipped.

In addition, these communities also have some gods. The clan gods of the Baheliyas of the eastern districts are Kalu Bir and Parihar. To Kalu Bir a young pig is offered and wine poured on the ground. Parihar receives a sacrifice of fowls and cakes. In Oudh a goat is sacrificed to Kale Deo. The chief god of the Kanjars is Mana. He is worshipped with the sacrifice of a pig or goat, or sheep, or fowl, and an offering of roasted flesh and liquor. Mekhasur (ram demon) is the tribal godling of the Aheriyas for whom they make a house shrine in a room set apart for the purpose.

While continuing the worship of their own deities, these communities have also taken to the worship of some deities of the Hindu pantheon, as also of animals, plants and rivers which the Hindus hold sacred. They have also adopted some of the Hindu festivals. Thus the Gandhilas and Haburas worship Parmeshwar, the supreme Hindu God The Sansiyas believe in great God, i.e. Bhagwan or Parmeshwar or Narayan. Like the Hindus, the Baheliyas hold the Ganga sacred and swear by her. The Beriyas bathe in the Ganga in the honour of their dead. When they take oath they turn to the river and swear by mother Ganga. The Bhantus also offer *arghya* (water) to *pipal*, tree, *tulsi* plant and sun. The Aheriyas venerate the *pipal* and have a special worship of the *aonla* (*Phyllanthus emblica*) on the eleventh of the light half of the month of *Phalgun*. For Nagapanchami festival their women draw pictures of snakes on the walls of their houses and throw milk over them. Men take milk to the jungle and place it before the hole of a snake. Their chief oath is either on the Ganga or stand under a *pipal* tree or hold a leaf of it in his/her hand. The Beriyas also celebrate the usual holidays Salono, Holi, Diwali and Dasahara. Most of the festivals of the Aheriyas are those common to all Hindus.

Some of them have also started using the services of Brahmin priests in their ceremonies and rituals. Among the Baheliyas the ordinary low village Brahmins act as their priests at domestic ceremonies. All the Haburas call themselves Hindus though they accept little or no service from Brahmins. The Beriyas employ Brahmins only for giving omens at marriages, and it is only the very lowest Brahmins who serve them. Among the Aheriyas a match is arranged with the help of a Brahmin and barber.

Due to contact with the Muslims these aborigines have adopted the worship of a number of Muslim saints. Thus the Bawariyas worship Zahir Diwan, and the Aheriyas worship Panch Pir's shrine near Aligarh. The offerings at the shrine are taken by a Muslim. The Aheriyas also worship Miyan Sahib and Jakhiya. Many of the Beriyas worship Sayyid which they understand to represent Muhammad, the prophet. The Bhantus also worship Sayyid. The Sansiyas have a belief in a godling known as Miyan, who may be Ghazi Miyan or the saint of Amroha and Jalesar. The Beriya is either Hindu or Musalman according to the population he lives in. Some are Kabirpanthis or Sikhs, some disguise themselves as Jogis, Faqir, etc.

Even while not fully integrated into the caste structure of the Hindu society these aboriginal groups have to a certain extent imbibed the ideology of caste, and they observe the taboos with regard to food and drink in their dealings with other kindred groups as well as caste societies. Thus the Baheliyas will not touch a Bhangi, Dom and Dhobi. The Aheriyas will eat *kachchi* (cereal food cooked in water) only from the Ahirs, Barhais, Jats and Kahars; they eat *pakki* (cereal food cooked by frying in *ghee* or oil) from a Nai. No other caste will eat with the Gandhilas, but some of them eat food from the hands of Kanjars, Sansiyas and similar vagrants. Among the Sansiyas those who are beginning to settle down claim, however, a much greater degree of purity and pretend not to eat *kachchi* except from high castes. The Haburas in Aligarh will not take food from the four castes Chamar, Dhobi, Bhangi and Kalar. In Bijnor they will drink from the hands of all Hindus except Chamars, Bhangis, Kanjars, Sansiyas and the like. In Bijnor, Mathura and other places they will eat the leavings of all high caste Hindus The Haburas who have settled down to agriculture and become fairly respectable members of society are gradually shedding the filthy habits and customs of their vagrant type under the influence of Hindus. By and by as they become more civilized, they trace their pedigree to the Rajputs. In Etah it is reported that if a member of the tribe commits any theft or immorality, he is excommunicated for a certain time and is not admitted until he draws blood from some part of his body, usually the nose.

The impact of Hinduism is particularly evident on the methods of disposal of the dead among these communities. Their traditional method of disposing of the dead was by burial or exposure or submersion in water whereas among the Hindus it is invariably by cremation except in very special cases. But slowly the aborigines are giving up other methods in favour of cremation. The Kanjars use three different modes to dispose of their dead; submersion in deep water by fastening a stone to the corpse; cremation; and burial. The first method is the least common; the last is the one most frequently practised as well as the most highly esteemed. The method of cremation, Nesfield thinks, may have been borrowed from the Hindus. Among the Baheliyas the dead body is cremated. The attendant rites are similar to those of the Hindus. The Bawariyas burn the adult dead and bury the unmarried people. Among the Aheriyas the rich people cremate the dead; poorer people bury, or consign the corpse to some river. After cremation the ashes are usually taken to the Ganga, but some people leave them at the pyre.

The Beriyas and Haburas are described as being in the intermediate stage between burial and cremation. The Beriyas of Farrukhabad touch the left foot of the corpse with fire and then bury it In Etawah they cremate the dead and collect the ashes, which they put into an earthen pot, and then bury this in the ground, raising over it a small earthen platform. The Haburas in Mathura either cremate and leave the ashes where the corpse was burnt, or throw the corpse into the Jamuna. In Bijnor they either bury or expose the corpse in the jungle. In Aligarh, when they are well off, they cremate the dead. From Etah it is reported that when a man dies at home he is cremated, the bones are buried on the spot, and a masonry platform erected over them. If a man dies at a distance from home, his bones are brought to one of the regular camping places of the tribe, and are there buried.

The real vagrant Sansiyas often merely expose their dead in the jungle. In Aligarh the Chanduwala Sansiyas cremate the dead; with the others burial is the rule. In Mirzapur they bury the dead. Bhantus of all *gotras* (clans), except that of Dholiya, cremate their dead.

Assimilation Into the Caste System

Large sections of these hunter-gatherers have been completely assimilated into the Hindu society over the millennia. But they were largely relegated to the lowest position (of untouchables) in the caste hierarchy because of their economic position (hunting-gathering), their food habits (eating wild animals despised by the Hindus, and consuming liquor), general poverty, ignorance of Brahmanical ritual, and lack of political power. In the case of the Aheriyas, for example, Sir H. M. Elliot describes them as a branch of the Dhanuks from whom they are distinguished by not eating dead carcasses, as the Dhanuks do. The Dhanuks are an untouchable Hindu caste who are now completely settled. They live by keeping swine and settle on the fringe of villages. The communities with less obnoxious food habits and possessing craft skills useful to Hindu society were given higher status. This is the only way in which the existence of the large number of artisan, service, and untouchable castes in the Ganga plains can be explained. Nesfield's apt and beautiful description of this process in the case of the Kanjars is equally applicable to other hunter-gatherer groups, and is worth quoting in extenso:

'In most of the arts or industries of the Kanjars it is easy to recognize functions or germs of functions, one or other of which has long been the stereotyped hereditary calling of certain inferior castes, such as Bahaliya, Bari, Behna, Chamar, Dharkar, Kori, Kalwar, and others; and hence we may reasonably conclude, that the wandering and predatory tribes, which were once universal in Upper India, but of which now only a few fragments remain, were the *rudis indigestaque moles*, out of which the several castes, with their respective functions, were fashioned by slow degrees.

'What we see now of the Kanjar people is no doubt a mere fraction of what they formerly were; and it is probable that, in the course of their history through the long centuries that have passed, their original tribal system, if they ever had one, has been shattered to pieces, and new groups have been formed at different times from the fragments that remained. 'This jungle nation is gradually dying out, or (to speak more correctly) is becoming more and more absorbed into the far mightier jungle of Indian caste, like the other great nations of this country, which were swallowed up centuries ago or are being swallowed up still. At the present time, for example, (and there are many parallel instances), several little encampments of Kanjars are dotted around Lucknow; and most of these have halted, where they still are, without a break for the last seven or eight years or more. These are gradually learning Hindu rites and forgetting their own. The Brahman, ever as keenly on the scent for fees as the Kanjar is for jackals, has found them out, and is silently drawing them into the net, from which there is no escape. The day of their capture is not far distant.

'In the Hindu sacred books, of which Brahmans are the professional expounders, the strictest rules, enforced by the most appalling penalties, are laid down against the communication of divine knowledge to persons or tribes outside the privileged pale. But the remote prospect of these awful consequences does not weigh so much as a feather against the immediate attractions of pice. It is by thus trading on the ignorance and superstition of indigenous tribes, that Brahmanism, setting out some 3,000 years ago from its narrow cradle on the banks of the Saraswati, has continually enlarged its borders, until this enslaving creed has now at last become the almost universal taskmaster of the Indian race.

'If admissibility into caste depends upon qualifications of function, then it is easy to see from the arts and industries in which Kanjars excel, that there are many low Hindu castes, into which they could be absorbed at once, if they would drop their tribal name, renounce their freedom, and consent to practise the same worship and the same marriage rites as those of the caste or castes into which they seek to enter. It is impossible to say how many of the caste men, who are now called Chamars, Koris, Pasis, Behnas, Baris, etc., were not originally Kanjars; or how many Kanjars may not have risen imperceptibly, at an earlier stage of their history, into the ranks of castes holding a much higher status than these in the social scale. There is one caste called Ḳhangar, the members of which, if we are to trust the similarity of name, must have been Kanjars, not many years ago. They are a low and despised caste, still known as hunters and trappers in a small way, but chiefly employed as general drudges, field-labourers, night-watchmen, and swineherds, a squalid, fever-stricken, spirit-broken tribe, which has lost the healthy life, the versatile genius, and the happy freedom of their brethren of the forests' (Nesfield 1883:397-398).

Conclusion

Hunter-gatherer communities have lived in the Ganga plains from the Mesolithic period (c. 8,000 B.C.). With the introduction of agricultural economy from second millennium B.C. onwards village and urban centres grew up steadily. As a consequence the habitat of the hunter-gatherers was modified with increasing intensity. From then on they had to share their environment with peasant, pastoral, and trading communities, and were drawn into exchange systems and market economy. In response to the changes in their natural and social environment they rescheduled their traditional economic strategies by orienting their technical skills for providing goods and services to the village and urban populations. These goods included honey, meat of wild game, minor forest produce, hides for drums, baskets, winnowing fans, palmleaf fans, ropes, weavers' brushes, mats, leaf platters and cups, screens of *khaskhas* grass, thread of cotton tree fibre, and grinding and milling stones. The services they usually rendered were acting as medicinemen and surgeons, suppliers of herbal drugs and perfumes, entertainers and herders of buffaloes and camels. Some groups like the Aheriya, Baheliya, Sansiya and Habura became professional thieves and robbers while continuing their traditional economic behaviour.

Economic interaction with Hindu society naturally brought them under the influence of the caste system. Sections of these communities were completely assimilated into this hierarchical system and were assigned a social ranking in conformity with the professional services they rendered, and their lifeways, specially their food habits. Others who continued to persist with their traditional modes of living remained on the periphery of Hindu society. However, the acculturation of these groups into the larger society has been an ongoing process, and it has been considerably accentuated by the increase in the pace of economic and social development after Independence. In their turn, these communities have been trying to improve their status in the caste system by tracing their ancestry to Hindu folk heroes and by adopting Brahmanical rituals and food habits. Their categorisation as Scheduled Castes by the government hinders this effort even while it entitles them to preferential treatment in educational and employment opportunities.

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Excavation at Bharat Bhayna Mound, Bangladesh : a Preliminary Report

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Introduction

Situated in the south-west of Bangladesh, the archaeological site of Bharat Bhayna is located in the village of the same name in District Jessore. It is 20 km south-west of Daulatpur and 18 km south-east of Keshabpur. It is located on the western bank of river Buri-Bhadra. The mound rises 12.20 m above the surrounding field. According to the local inhabitants it was much higher before the earthquake of 1897. The circumference at the base of the fairly circular mound is about 250 m It is reported that a modern temple was built close to this mound by removing large quantities of bricks from the latter (ARASI 1923 : 76). Some deep, irregular trenches near the crest testify to the vandalism which in course of time came to be associated with a number of fantastic local legends.

In 1922, the mound was given protected status by the Archaeological Survey of India. K.N.Dikshit who surveyed it suggested that the mound covered an ancient Buddhist temple of the 5th century A.D. and probably was one of the 30 sangharamas of 'Samatata' mentioned by Hien Tsang (ARASI 1923 . 76).

The mound has been disturbed by brick-hunters at various times in the past. Recently the landowners levelled a considerable portion of the slopes of the mound for the extension of their cultivable lands. Satish Chandra Mitra (1936 : 121) mentions that there was a garkhai (moat) probably intended for the protection of the monument. The present topography of the mound, however, clearly precludes any possibility of its ever being a sangharama encircled by a moat as surmised by Dikshit and Mitra (ARASI 1923 : 76, Mitra 1936 : 121).

The supposed ancient temple is said to have been built by a mythical king named Bharat. Remains of another ancient site locally known as 'Bharat Rajar Badi' (house of king Bharat) are located on the bank of river Buri-Bhadra in the village of Gaurighona about 2 km south of this mound. Another mound known as 'Dalijhara' is located in the adjacent village of Kashimpur. Local legends describe it as the residence of a royal official of that king. Yet another site named 'Bharatgarh' is situated in the Sundarbans which is also said to have been ruled by a king named Bharat (Mitra 1936 : 122). The identity of this legendary king Bharat is highly uncertain. It is also uncertain whether King Bharat of Bharatgarh and the Bharat associated with the mound of Bharat Bhayna are the same or not.

Excavation

The Department of Archaeology and Museums of Bangladesh carried out an excavation at this mound in 1985 in order to study the cultural wealth buried under it and to assess the historicity of the site. Excavation was concentrated on the top and the eastern and southern slopes of the mound.

The excavation has partly exposed the remains of a building whose superstructure seems to have been completely destroyed. The exposed structural remains are as yet too insufficient to allow for identification of its layout. The exposed structure appears to be the massive foundation of an imposing superstructure which has not survived. The foundation closely resembles similar structures at Ahichchatra in Bareilly district of U.P., India (Ahmed 1975 : 50), at Gokul Medh (Ibid), and at Bihar Mound (Alam 1983) in Bogra district, Bangladesh. The excavated remains consist of an irregular series of blind cells of various shapes and sizes of which 40 cells have so far been exposed (Fig. 1). These cells were compacted with earth and probably served as a re-enforcement for the foundations of the lofty superstructure. As the excavation was carried out in a very limited area it was not possible to follow a clear plan or general alignment of the foundation walls. The antiquities recovered are few and not indicative of any definite chronology.

1. Main Building

The main edifice rests on a series of irregular blind cells and was exposed in five squares. Three of these (Square C III-25, C IV-16 and D IV-1) are on the top and two (Square D IV-16 and D IV-21) are along the slopes of the mound on its eastern side. Generally, only a single course of bricks is observed (for example Square C III-25, D IV-1 and D IV-16) but in one trench (C IV-16) two courses of bricks are noticed. Two east-west oriented narrow walls, each 71 cm wide, have been traced in the middle of the eastern slope (Square D IV-1). They continue up to five successive courses of bricks above the foundation. On the eastern margin of the mound (Square D IV-21) three heavily damaged walls running north-south have been exposed. They extend up to 2.07, 3.15 and 2.10 m respectively. Their foundations are not uniform. Remains of the main building exposed at different levels indicate that the superstructure might have been built in gradually rising tiers. However, this feature is likely to unfold itself more clearly with further excavation at the site.

ii. Foundation (Fig. 1)

It is already mentioned that the remains exposed so far are the foundation or high podium of the main building. The main building, either a shrine or a stupa, was built 11.88 m above the ground level on a solid foundation gradually raised by means of a number of cross walls of various dimensions and oriented in different directions (north-south and east-west)

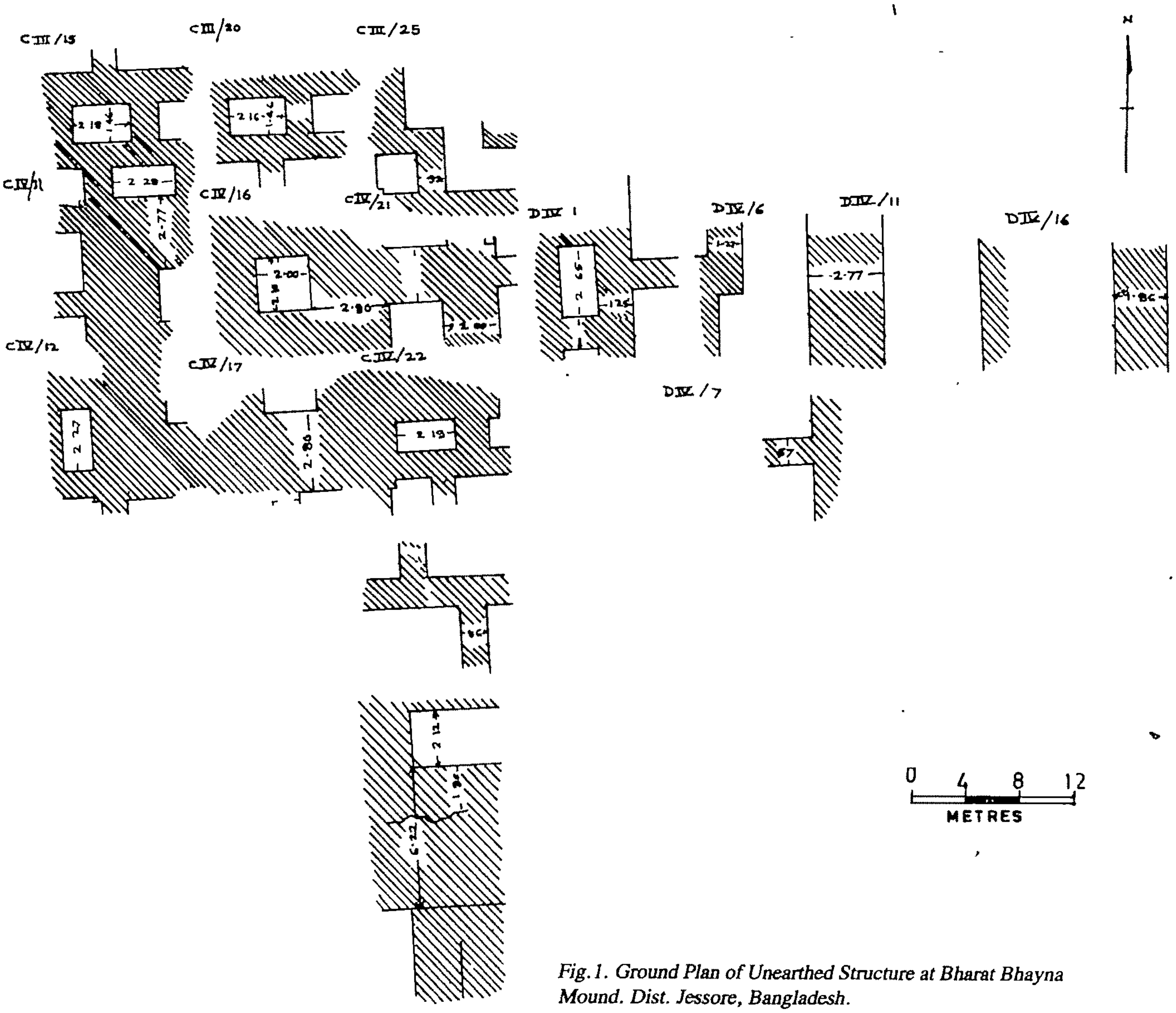

Fig. 1. Ground Plan of Unearthed Structure at Bharat Bhayna Mound. Dist. Jessore, Bangladesh.

forming a cellular structure. The intervening spaces of the cross walls were compacted by an earth filling. A number of these blind cells have been exposed during the excavation, of which eight have been exposed fully and 32 partly. It appears that the principal cella of the main building was built over the massive square central block of the cellular structure, located in the middle of the mound. The central block externally measures 11.30 x 11.30 m and consists of four blind cells. The walls of these cells are very thick (2.80 m wide) in comparison with other parts of the foundation. Only one blind cell of this block has been exposed fully and the three others partly. The fully exposed cell is roughly a square internally measuring 2.10 x 2.00 m. The corners of the central block were provided with projections. To the east of this central block one more cell with a 2 m. thick wall was encountered. The eastern corner of this cell was also provided with projections. Other cross walls around the central block are of various dimensions (such as 0.81, 1.01, 1.51, 1.27, 1.25 and 1.23 m). A 1.80 m wide wall, which is aligned east-west, has been exposed at a distance of 12.30 m south of the central block. The outer face of this wall is decorated with projections. Beyond this wall, another massive wall (3.50 m wide) seems to have been erected at a later period. It is still not clear whether this wall was rebuilt after the former had collapsed or whether it is an altogether new wall belonging to a later period.

In order to expose the foundation of the monument, deep digging was conducted in two cells, one inside the central block of the foundation and another adjacent to it. The former cell has been dug to a depth of 6.50 m and the latter, to a depth of 3.90 m. The massive wall of the foundation structure was exposed up to 6 m from the top in the cell inside the central block and is found to extend deeper.

Mud mortar has been used in the walls of the building. Only a few complete bricks of varying dimensions (34 x 22 x 5 to 36 x 24 x 6 cm) survive. The majority have been broken.

Antiquities

During the present excavation only 14 antiquities were recovered. When the brick-hunters destroyed the main building, probably all the objects associated with the monument were plundered or displaced. The small number of antiquities which we collected from the site are mostly fragments of objects. Perhaps these were broken in the course vandalism and were thrown into the debris. This possibly also explains why almost all the antiquities were found in the debris of layer (1) and (1A).

There are four fragments of terracotte images. Of these, three contain only some parts of the hands of figurines. The fourth fragment represents the foot of the right leg of a human figure. Most probably the foot is in a dangling position over a pedestal (?). Other notable antiquities are an earthen oil lamp, an earthen miniature pot, one ornamental brick, and two bricks containing footprints of animals.

Pottery

In the course of excavation a few potsherds were collected. All of them are broken and do not give any definite idea about their form. They are fragments of the rim, neck and base of different household wares such as pitcher, bowl, saucer, lid, oil lamp and sprinkler's top.

The sherds are of various colours and textures, mostly pale reddish with a few deep ash and buff coloured. Almost all of them are thick textured and a few are medium textured. A few sherds contain some designs. The designs are herring-bone, parallel lines, net etc.

Conclusion

The structure so far exposed at the site appears to be a cellular foundation of an imposing superstructure which has entirely disappeared. The negligible quantity of antiquities recovered do not help much in determining the chronology of the site. The major portion of the structure is still buried under the unexcavated portion of the mound. K.N. Dikshit tentatively identified it as the remains of a temple and on the tenuous evidence of the brick size he assigned it to the Gupta period. It is premature to confirm or refute Dikshit's view at this initial stage of the excavation. Further digging at the site may help us in this respect.

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Petrography of Harappan Pottery from Lothal

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Thin-section microscopy has been extensively used for examining rock, mineral and ceramic samples. This enables the petrologist to study the texture and mineralogy of these samples and thus identify the optical properties of minerals included in them.

Representative samples of different varieties of Pottery recovered in the excavation at Lothal were studied by preparing their thin-sections using a polarising microscope. The mineral inclusions found in the thin-sections were identified according to their optical properties. Textural analysis of the pottery was carried out by determining the grain size, grain shape and percentage of non-plastic inclusions in each specimen. The size of the non-plastic inclusions present in the thin-sections of Lothal pottery whose study is presented here is fine. There are no larger particles of quartz, feldspar or limestone in them.

Lothal (22° 31' N., 72° 14' E) is a well known Harappan site in Gujarat (Rao, 1973). It is located at 84 kms south-west of Ahmedabad and 7 kms east of Bhurkhi, a small railway station now renamed as Lothal-Bhurkhi, on the metre gauge line of the Ahmedabad-Bhavnagar section of the western Railway. Geographically, Lothal lies at the head of the Gulf of Cambay at a distance of about 25 kms from the sea. This area falls in a lowlying saline tract of the Bhogavo basin which forms a boundary between the Saurashtra Peninsula and the mainland of Gujarat. A tributary of the Bhogavo flows 3 kms south-west of Lothal. Much of the Saurashtra Peninsula is covered by the Deccan Trap formations. The river Bhogavo has its source in this Deccan Trap. Besides the Bhogavo, the Sabarmati which originates in the Aravalli hills also flows at a distance of 10 kms from Lothal. The soil around Lothal is loamy or clayey, formed by the deposition of the river alluvium. Between the two rivers, the Sabarmati has more significant role to play in this area. When the rivers are in flood the alluvial fans coalesce, the detritaes brought by the Sabarmati dominating over that of the Bhogavo.

In some respects, the layout of the settlement at Lothal is different from that of other important Harappan sites. This may be due to the different role that this site played as a Harappan trading station. This site is nearly rectangular, surrounded by a massive brick wall. On the eastern side of the site is a brick basin, claimed to have been a dock-yard connected by channels to the neighbouring estuary. Besides this basin there is a brick platform which probably served as a simple flood defence. An important part of the raised part of the site contained brick platforms intersected by ventilating channels, representing perhaps the foundation of a large warehouse.

According to the excavator (Rao, 1973), Lothal was a Harappan port town established around 2450 B.C. Harappan habitation continued here until 1600 B.C. Excavations at Lothal have revealed two periods. Lothal A - lasting from 2450 to 1900 B.C., represented by the mature phase of Harappa culture. Period B, lasting from 1900 to 1600 B.C., was marked by repeated floods and gradual deterioration in cultural life at the site.

Geomorphic Setting

The Harappan site at Lothal is located on an artificial platform amidst the featureless, low alluvial terrain, known as

Bhal This mound locally known as "timba" has a length of about 300 m along the north-south direction and 250 m along the east-west directions, covering an approximate area of about 75,000 m^2 The alluvial plain around Lothal is dotted with a north-west south-east oriented saline, marshy narrow tract, adjacent to the courses of the Bhogavo and the Sabarmati rivers These are known as raised tidal flats or raised mud flats that represent the limits of the Flandrian Shoreline. These mudflats often contain shell fragments of forminifera.

Pottery

When the Harappans came to Lothal they came into contact with an indigenous folk who used Black and Red ware and Micaceous Red ware. Besides these, grey ware, reserved slip ware and a variety of coarse pottery were also found at Lothal. Among the important shapes of pottery recovered at Lothal are dishes, dishes-on-stand, "S" profile jars, bowls, storage jars, perforated jars and miniature vessels.

The present paper discusses the petrographic study made on the Harappan Red ware, Buff ware and the non-Harappan Black and Red ware and Micaceous Red ware recovered in the excavation at Lothal.

Method of Study

Thin-sections of the representative pottery specimens belonging to Red ware, Buff ware, Black and Red ware and Micaceous Red ware collected from the stratified horizons at Lothal were prepared and studied under a polarising microscope The mineralogy of the non-plastic components present in the potsherds was studied by observing their optical properties (Phillip *et al.*, 1981) This was then compared with the mineralogy of the detritals present in the clay samples collected from the mud flats within the vicinity of the Harappan settlement at Lothal.

Results

(i) Red ware

Among the samples analysed, the Red Ware variety consists of both fine and coarse pottery. The majority of mineral grains were found to be angular to subangular in shape. Only a few grains were found to be rounded to subrounded. Besides these, calcite was also found in many of the thin-sections of this pottery. It is of crypto-crystalline nature and in most of the cases it has occupied the pores. Patches of haematite are also seen in these sections. The major detrital particles present in the sections were of quartz, augite, feldspars, mica, hornblende, crypto-crystalline silica and fragments of basalt. They also contained a certain amount of altered pellets of microfossil fragments of foraminifera: The relative abundance of these non-plastic inclusions and their grain sizes were also determined *(Figs 1,2)*

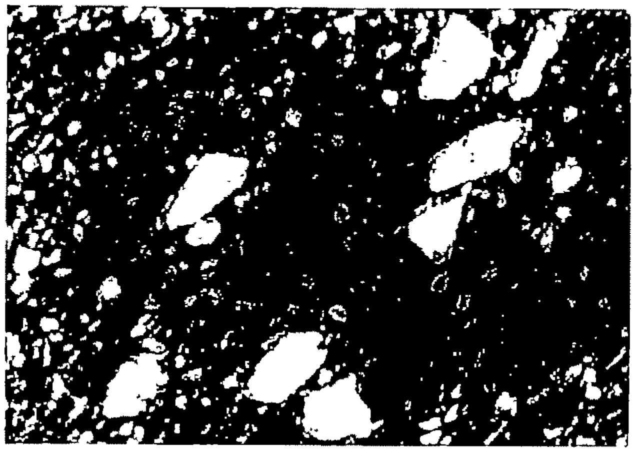

Fig 1 Photomicrograph showing angular to subangular grains of quartz in Red ware (x30, Crossed Nicols).

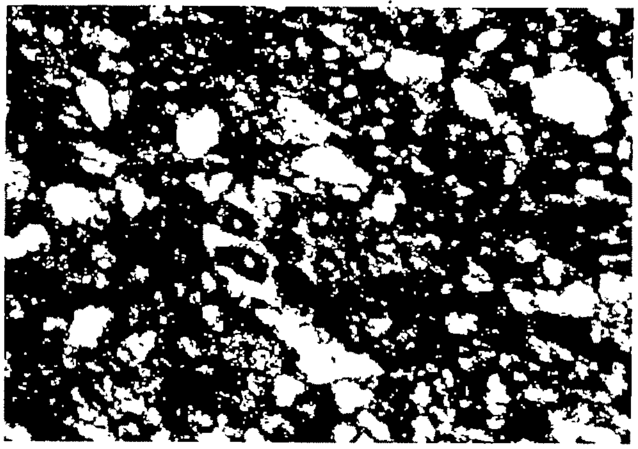

Fig.2 Photomicrograph showing relict microfossils (x 30, Crossed Nicols).

(ii) Buff ware

The thin-section study of this Pottery revealed similar angular to subangular grains of quartz, feldspars, augite, hornblende, mica, zircon as in the case of Harappan Red ware Iron oxide was found in the sections in patches. In general, the grains were well sorted and varying in size from 0.1 to 0.35 mm. A few grains were found to be rounded or subrounded. Some of these grains show a well defined elongation A characteristic feature of Lothal pottery is that it contains a considerable amount of altered pellets of microfossil fragments of forminifera *(Figs 3,4)*

(iii) Black and Red ware

The thin-sections of this pottery revealed fine and scattered angular to subangular grains on quartz, augite feldspars, hornblende, mica and rounded pellets of microfossils. The grains are sorted and their size varies between 0.1 and 0.30 mm. The matrix is fine grained and dark coloured (*Fig.5*).

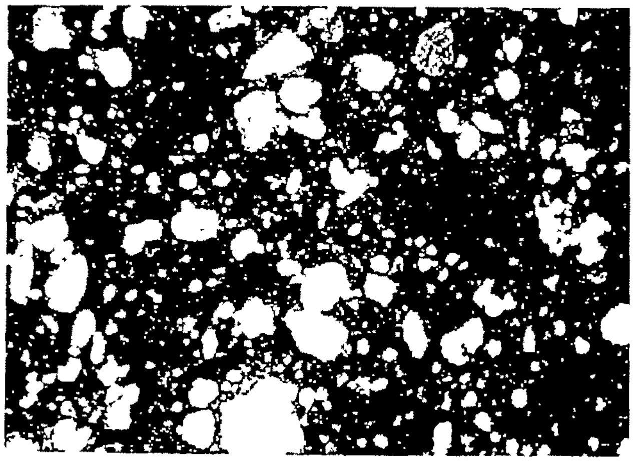

Fig.3. Photomicrograph showing the textural characteristics of Buff coloured potsherd (x30, Crossed Nicols)

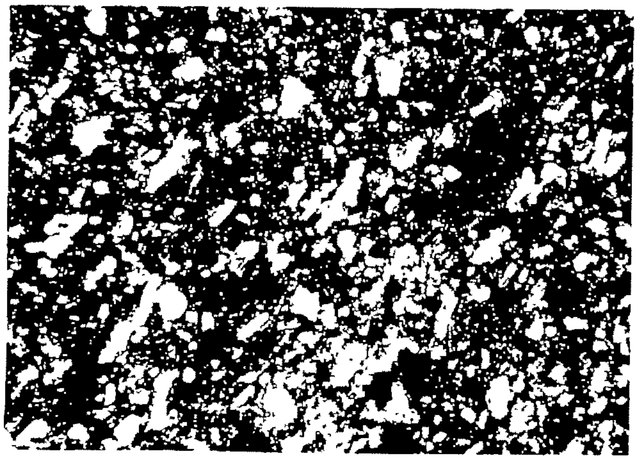

Fig.4. Photomicrograph showing elongation of mineral constituents in Buff coloured potsherd (x30, Crossed Nicols).

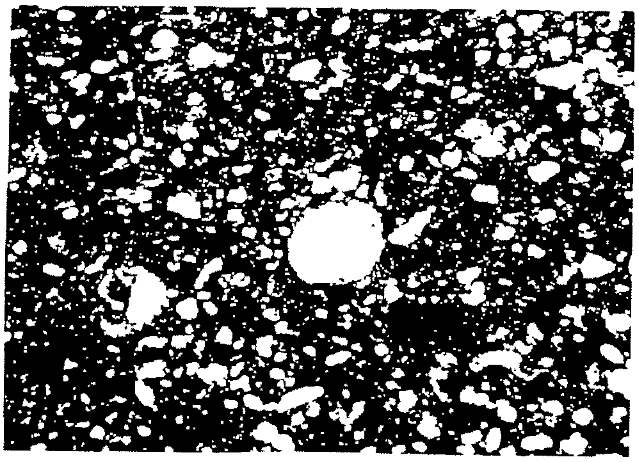

Fig.5. Photomicrograph showing partially and fully recrystallised microfossils in Black and Red potsherd (x30, Crossed Nicols).

(iv) Micaceous Red ware

Thin-sections of the Micaceous Red Ware pottery revealed angular to subangular grains of quartz, plagioclase, feldspars and mica particles. The grains are sorted and their sizes vary between 0.1 to 0.30 mm. The colour of the clay matrix varied from yellowish red to darkish brown. Mica is tiny, platy crystal which is concentrated along with clay when it is repeatedly elutriated. The above evidence suggests that the clay used in preparing the Micaceaous Red ware was repeatedly elutriated (*Fig.6*).

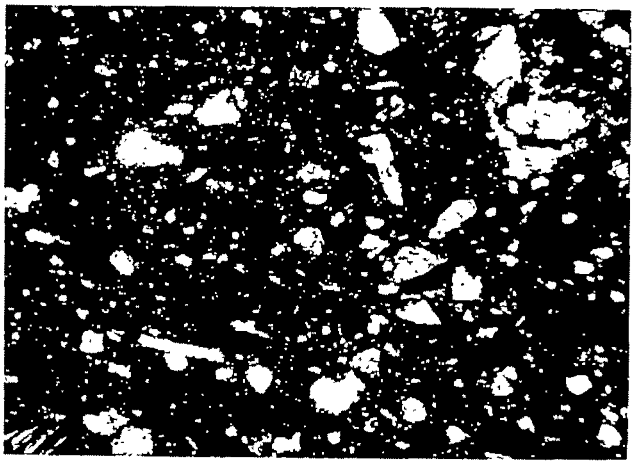

Fig.6. Photomicrograph showing quartz, plagioclase, feldspars and mica particles in Micaceous Red ware (x30, Crossed Nicols).

(B) Raised Tidal Flats

The thin-sections prepared from the samples obtained from the mudflats near Lothal showed abraded pellets of microfossils and quartz, together with a few grains of feldspars and heavy minerals such as augite, hornblende and garnet (*Fig.7*).

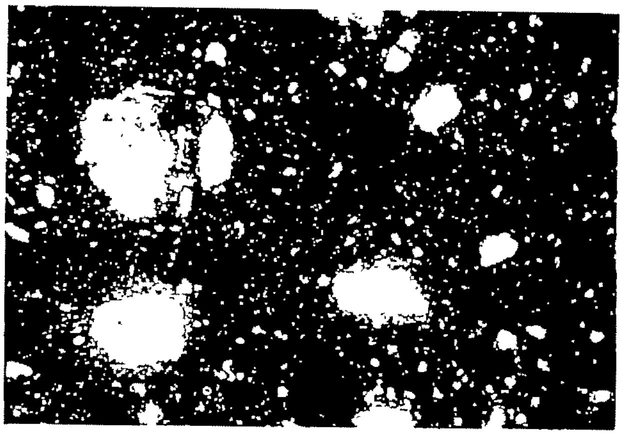

Fig.7. Photomicrograph showing plagioclase and feldspar (x30, (x30, Crossed Nicols).

Discussion

The Bhogavo river flows through the basaltic areas of Saurashtra. On the other hand the Sabarmati and its tributaries (Hathmati, Vatrak, Sedhi, etc.) originate in the terrain of North Gujarat, which contains a variety of metamorphic rocks including quartzites, phyllite schist, gneiss, calcschist, calcgneiss, granite and granodiorite and also numerous small intrusive acid and basic igneous rocks. The trappean rocks of Saurashtra are very susceptible to disintegration and weathering. The detritus derived from these rocks is represented in the tidal mud or mud flats. Geomorphic evidence clearly suggests that the Gulf of Kutch and the Gulf of Cambay were once connected by an inlet of an ancient sea (contemporary with the Flandrian transgression) when the sea level was about +8 to +10 m. above the present day sea level. The part of the Bhogavo river basin and the well known tourist site of Nal lake represent the remnants of this transgressive phase. This shallow sea provided a suitable environment for a flourishing microfaunal growth.

Lothal, being an ancient trading centre, was located near one of the creeks that met the arm of this sea. Being nearer to the mouth of the Sabarmati, Lothal was probably subjected to the influence of the tidal muds and sediments brought by the Sabarmati river from the north Gujarat region. The surf action of the tides have abraded the microfossils.

Conclusion

The thin-section studies have revealed the presence of non-plastic inclusions such as quartz, augite, feldspars, mica, hornblende, crypto-crystalline silica and fragments of basalt rock. The analysis of clay samples collected from the mud flats near the Harappan settlement of Lothal has also revealed the mineralogical composition of the detritals present in them. From the comparative study of the mineralogical composition of the detritals present in the thin-sections of the pottery and clay samples, it appears that the Harappan Potters of Lothal exploited the locally available clay. The provenance of the clay of the Harappan as well as the non-Harappan pottery at Lothal is also the same.

I am thankful to Prof. K.T.M. Hegde for his constant help and criticism during the preparation of this papaer.

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Archaeobotanical Investigation on Megalithic Bhagimohari, and its Significance for Ancient Indian Agricultural System

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Introduction

The present work brings to light evidence for ten cultivated and four wild plant species from excavations carried out at the Megalithic site of Bhagimohari (78° 51′ E : 21° 26′ N), district Nagpur in Maharashtra(Fig. 1). It also discusses significance of the present findings to advancing our knowledge of exploitation of agricultural crops and various wild plant species during the 1st millennium B.C. The site of Bhagimohari lies about 47 km (as the crow flies) north of Nagpur on Nagpur-Multai road. It was excavated jointly by Prof.S.B.Deo, then Director of the Deccan College Post-Graduate and Research Institute, Pune and Dr. A. P. Jamkhedkar, Director, Department of Archaeology and Museum, Government of Maharashtra, Bombay during 1982-83 and 1983-84. The excavations revealed Megalithic stone circles as well as habitational deposits. The burial sites (stone circles) lie on the left bank while the habitational site lies on the right bank of the river Kolar about one km apart from one another. During both seasons of excavations flotation technique (Kajale 1979) in the form of wet sieving was applied to the representative habitational debris. Organic assemblage comprising carbonized and semi-carbonized grains, molluscan shells, charcoal, wood pieces, etc. was retrieved. In addition, samples of dry soil, clay objects, potsherds and mud-bricks were thoroughly (magnascopically and microscopically) examined to fish out the possible botanical materials occurring in the form of carbonized and semi-carbonized grains, husk impressions, compressions and silica skeletons. In this way extremely rich and diverse botanical materials could be salvaged from the site even with the limited extent of excavation. Identical Black and Red Ware pottery types, copper and iron ornaments, weapons, faunal remains, etc. have been unearthed from stone circles as well as habitational deposits. These findings were broadly similar to those from other sites like Naikund and Takalghat Khapa. Radiocarbon dates from the burial sites and habitational site of Bhagimohari are fairly close and thereby suggest contemporaneity of the two (personal communication : S.B.Deo).

Results

The Plant remains have been obtained from the lowest (9) to the topmost (1) layer of the habitational deposits. Almost all the levels are very closely dated by radiocarbon measurements through the courtesy of Dr. S.Rajagopalan, Head of the Radiocarbon Laboratory of the Birbal Sahni Institute of Palaeobotany, Lucknow. These dates are without the Masca corrections and are based on a half life value of 5570± 30 years.

Discussions

For assessing role of ancient plant economy at Bhagimohari, it would be worthwhile referring to the radiocarbon chronology of the present site (summarised in Tables I and II) as well as similar palaeoethnobotanical findings from other Megalithic sites in India (Fig.1 and Table III). The eleven radiocarbon dates from Bhagimohari (with the exception of couple of erratic dates) form a more or less consistent and progressive series (personal communication: S.B. Deo). They provide a firm sequence of Megalithic habitation and thus eventually the chronology for the exploitation of vegetational resources around the site. Among the cultivated

TABLE I : SUMMARISED FINDINGS OF THE 1982 - 83 SEASON'S EXCAVATIONS (+ AND - INDICATES PRESENCE AND ABSENCE RESPECTIVELY)

Sr. no.	Common name	Botanical Name	Habitational layers with radiocarbon determinations						
			(3)	(4)	(5)	(6)	(7)	(8)	(9)
			{No date}	{490±100 B.C.}	{no date}	{500±100 B.C.}	{450±100 B.C.}	{620±80 B.C.}	{690±100B.C.}, {750±100B.C.}
1.	Barley	(Hordeum vulgare Linn.)	+	+	−	−	−	−	−
2.	Rice	(Oryza cf sativa Linn.type)	−	+	+	+	−	−	+
3.	Job s tears	(Coix lachryma jobi Linn.)	−	−	−	+	−	−	−
4.	Black gram	(Vigna mungo (Linn.) Hepper	+	+	−	+	+	+	+
5.	Lentil	(Lens esculenta Moench.)	+	−	+	+	−	+	+
6.	Hyacinth bean	(Dolichos labalab Linn.)	−	+	−	+	+	−	−
7.	Common pea	(Pisum arvense Linn.)	+	+	−	−	−	+	+
8.	Grass pea	(Lathyrus sativus Linn.)	+	−	−	−	−	−	−
9	Pigeon pea	(Cajanus cajan Millsp.)	−	−	−	−	−	+	−
10.	Black gram/ Green gram	(Vigna sp.)	−	−	+	−	−	−	−
11.	Indian jujube	(Zizyphus jujuba Lamk.)	−	−	−	−	−	+	+
12	Indeterminate type(legume)		+	−	+	−	−	−	−
13.	Indeterminate type(hollow)		+	−	−	−	−	+	+
14.	Indeterminate type		−	−	−	−	+	−	−

TABLE II : SUMMARISED FINDINGS OF THE 1983 - 84 SEASON'S EXCAVATIONS (+ and - INDICATE PRESENCE AND ABSENCE RESPECTIVELY)

Sr.	Common name	Botanical name	Habitational layers with radiocarbon determinations							
			(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
			(no date)	(no date)	(490±100 B.C)	(no date)	(500±100 B.C)	(450±90 B.C)	(600±100 B.C)	(750±100 B.C)
1.	Barley	(Hordeum vulgare Linn.)	–	+	–	–	–	–	–	–
2.	Rice	(Oryza cf sativa Linn.)	–	+	–	+	+	+	+	+
3.	Common pea	(Pisum arvense Linn.)	+	+	+	+	–	+	+	+
4.	Lentil	(Lens esculenta Moench.)	–	–	+	+	+	+	–	–
5.	Black gram	(Vigna mungo (L.) Hepper	+	+	+	–	–	+	+	+
6.	Grass pea	(Lathyrus sativus Linn.)	–	–	–	–	–	–	+	–
7.	Horse gram	(Dolichos biflorus Linn.)	–	–	–	–	–	+	–	–
8	Hyacinth bean	(Dolichos lablab Linn.)	–	+	+	–	–	–	–	–
9.	Indian jujube	(Zizyphus jujuba Lamk.)	–	+	+	+	–	+	–	–
10	Goosefoot (Bathen)	(Chenopodium cf album L.type)	–	–	–	–	–	+	–	–
11	Molluscan shells	(juvenile forms)	–	–	+	–	–	+	–	–

TABLE III : COMPARATIVE GRAIN FINDINGS FROM MEGALITHIC SITES IN INDIA (WITH RADIOCARBON DATES WHEREVER POSSIBLE,
+ AND - INDICATES PRESENCE AND ABSENCE RESPECTIVELY)

Sr no.	Plant species.		Bhagimohari, District Nagpur, Maharashtra. (C.800± 400 B.C.)	Naikund, District Nagpur, Maharashtra. (700± 300 B.C.)	Khairwada, District Nagpur, Maharashtra. (C.500 B.C.)	Paiyanmpalli, District North Arcot, Tamilnadu. (C.316 ±100 B.C.)	Veerapuram, District Kurnool, Andhra Pradesh. (500 _300 B.C.)	Koppa, District Mysore, Karnataka, (1st millennium B.C.) (Personal Observation)	Hallur, District Dharwar, Karnataka. (C.1000 B.C.)	*Adichanalur, District Tirunelveli, Tamilnadu. (1st millennium B.C.) (Rea 1915)	Gajjalkonda, District Kurnool, Andhra Pradesh. 1st millennium B.C.)	Fraserpet, District Kurnool, Andhra Pradesh (1st millennium B.C.)	Gufkral, District Pulwama, Jammu and Kashmir. (C.1200 B.C)	Burzahom, District Srinagar, Jammu and Kashmir. (C 1000 B.C)
1	Rice	(Oryza cf sativa L.type)	+	+	+	-	+	+	+	+	?	?	+	+
2.	Barley	(Hordeum vulgare L.)	+	-	-	-	+	-	-	-	-	-	+	+
3.	Wheat	(Triticum spp.)	-	+	-	-	+	-	-	-	-	-	+	+
4.	Kodo millet	(Paspalum scrobiculatum L.)	-	-	-	-	+	-	?	-	-	-	-	-
5.	Job's tears	(Coix lachryma jobi L.)	+	-	-	-	-	-	-	-	-	-	-	-
6.	Common pea	(Pisum arvense Linn.)	+	+	-	-	+	-	-	-	-	-	+	+
7	Lentil	(Lens esculenta Moench.)	+	+	-	-	+	-	-	-	+	-	+	-
8.	Grass pea	(Lathyrus sativus Linn.)	+	-	-	-	-	-	-	-	-	-	-	-
9.	Horse gram	(Dolichos biflorus Linn.)	+	-	-	?	+	-	+	-	-	-	-	-

10.	Common bean	(Hyacinth bean) (Dolichos lablab Linn.)	+	–	–	–	+	–	–	–	–	–	–	–
11.	Black gram	{Reported as Vigna mungo (L.) Hepper or Phaseolus mungo(L.)}	+	+	–	–	+	–	–	–	–	–	–	–
12.	Black gram/ Green gram	(Mostly reported as Phaseolus sp.)	+	–	–	?	–	–	–	–	–	–	–	–
13.	Red gram (Pigeon pea)	(Cajanus cajan Millsp.)	+	–	–	–	–	–	–	–	–	–	–	–
14.	Beleric myrabolan	(Terminalia belerica Roxb.)	+	–	–	–	+	–	–	–	–	–	–	–
15.	Cucurbitaceous seed		+	–	–	–	+	–	–	–	–	–	–	–
16.	Apricot	(Pyrus cf?armenica L.type)	–	–	–	–	–	–	–	–	–	–	+	–
17.		Celtis sp.	–	–	–	–	–	–	–	–	–	–	+	+
18.	Vine	(Vitis vinipera Linn. type)	–	–	–	–	–	–	–	–	–	–	+	+
19.	Goosefoot (Fathen)	(Chenopodium cfalbum Linn. type)	+	–	?	–	–	–	–	–	–	–	–	–
20.	Indian jujube	(Zizyphus spp.,at times as (Zizyphus jujuba Lamk.)	+	+	–	–	–	–	–	–	–	–	–	–
21.	Ragi?, Finger millet?	(Eleusine spp.)	–	–	–	?	–	–	–	–	–	–	–	–

* Outer coats of grains of rice and of the dry greains known in Tinnevelly as `samei´ in the baked earthenware utensils and many of the vessels contained rice and millet seeds. Detailed identifications not given.

species, barley, lentil, common pea and grass pea are the winter crops while rice, common bean, horse gram and black gram are the monsoon (summer) crops, suggesting that the ancient inhabitants not only knew the art of agriculture but also carried out their farming operations during both summer ('kharif') and winter ('rabi') seasons. This is essentially a continuation of the double cropping (co-planting?) and an agricultural system known in the Indian sub-continent right from the Harappan (c. end-3rd millennium B C.) through the Neolithic sites like Gufkral (Kajale 1982b), Burzahom (Vishnu - Mittre 1974, Buth and Kaw 1985) and northern Deccan Chalcolithic cultures which flourished during the earlier half of the 2nd millennium B.C. such as at Inamgaon (Kajale 1977), Apegaon (Kajale 1980), Navdatoli-Maheshwar (Vishnu-Mittre 1960, Kajale 1974). It is, therefore, clear that at least some of the Megalithic people could have been regular agriculturists and probably enjoyed sedentism during the major part of the year to carry out farming operations during summer and winter seasons. At least some of them must have been arable farmers who could produce enough food for the rest of the members of the society. Occurrence of tools of tillage (four hoes and three sickles) from the limited excavations clearly speaks in favour of agricultural nature of the settlements Also it is difficult to explain the occurrence of hundreds of stone circles (burial sites) without the support of food producing communities in the then society of Bhagimohari. This is suggestive of socio-economic divisions during the occupational history at Bhaimohari. Besides the above-mentioned evidences, bones of domesticated animals like cattle and sheep/goat constitute significant proportion of the faunal remains (personal communication : P K. Thomas).

It is true that the weapons such as daggers and swords far outnumber the agricultural equipments in stone circles but this may be because of the ritualistic significance of the former as opined by S.B.Deo (personal communication). Thus the integrated evidence of biological and cultural remains can give idea about the interactions amongst socio-economic, political and farming systems, agricultural eco-system and social stratification at any site besides human plant interrelationships. And probably Bhagimohari is one of the key Megalithic sites in this direction. The Megalithic people of Bhagimohari obviously knew the techniques of plant as well as animal domestication. The questions regarding surplus management can only be probed through detailed horizontal excavations in future and the botanical data can be of great help in modelling the evolution of societal differentiation. However, It still remains to be firmly established whether multiple cropping existed then. Nevertheless, it is only through such closely analysed and well dated botanical data that one can get insight into the antiquity of multiple cropping.

In the Vidarbha region of Maharashtra, there is a large concentration of Megalithic sites and the site of Bhagimohari stands out to be the richest as far as the agricultural economy is concerned. Next to it in Vidarbha is a site of Naikund which had yielded first definite evidence for agriculturally exploited plant assemblage (Kajale 1982a). At Khairwada (District Nagpur, Maharashtra), there is evidence for rice (*Oryza* cf *sativa* Linn.) and weeds of cultivation and disturbed lands such as goosefoot (fathen) i.e. *Chenopodium* cf *album* Linn. type (personal observation). The latter plant may have perhaps served as a vegetable plant in ancient times. From Table III it is seen that out of the 21 odd plant species reported from Megalithic context in India, more than fifty percent are present at Bhagimohari and rice had perhaps become the commonest ingredient of the staple during the 1st millennium B.C. It is not very wise to assess the relative economic importance of different plants on the basis of botanical findings alone as all the sites mentioned therein have been subjected to various levels of expertise in excavations, recovery of botanical materials and subsequent reporting. The most significant finding from Bhagimohari is that of pigeon pea (*Cajanus* cf *cajan* Millsp.) which is one of the oldest record of that species in India, the other one having come from the Chalcolithic site of Tuljapur Garhi (Kajale 1988a) in Amraoti district of Maharashtra dating 1st millennium B.C. The evidence for this species has also come to light from the Satavahana Bhokardan (Kajale 1974) (C.200 B.C.-200 A.D.), District Aurangabad, Indo-Roman Nevasa (Kajale 1977) (C 50 B.C.- 200 A.D.), District Ahmednagar and Historical Mungi in Aurangabad District, all in the state of Maharashtra. There is no firm archaeobotanical record of this species from Africa even though Vavilov (1951) considers it to be of secondary origin in Africa. Another interesting discovery is that of job's tears (*Coix lachryma jobi* Linn.). It has been extremely well preserved despite the fact that it is not carbonized. This unusual state of preservation is essentially because of its tough silica-rich covering (botanically 'involucre') This plant is cultivated in north-east India where the grains are used as 'pseudo-cereal'. The grains of wild plant are used as beads. Such plant beads made out of wild *Coix* have been found from sites like historical Anuradhapura (Deraniyagala 1972) in north-central Sri Lanka and early historical Ahichchhatra (Dixit 1952) in Uttar Pradesh, India. A few grains of *Coix* have been noted at Chalcolithic Inamgaon (C. 1600 - 7000 B.C.) in Pune District of Maharashtra (Kajale 1988b) and a mature Harappan site of Kuntasi in Rajkot district of Gujarat (personal observation). Its occurrence is also to be noted at Timore in Indonesia (Glover 1977). However, it is not clear whether the *Coix* was used for preparation of beads at Bhagimohari. Absence of man-made perforation in the *Coix* from Bhagimohari suggests that it may not have been used for making beads. The solitary evidence does not speak in favour of its probable cultivation. In all probability it was just a natural constituent of the wild plant community existing in the vicinity of cultivated fields and a few grains could have been accidentally collected by the occupants along with the harvesting of the cereals and pulses.

Amongst the South Indian sites Hallur (Vishnu-Mittre 1971, Kajale 1988c) has yielded evidence for rice, horse-gram, kodo-millet, hyacinth bean, Indian jujube and teak (*Tectona grandis* Linn.). The ancient plant economy at Veerapuram in Kurnool district of Andhra Pradesh (Kajale 1984) and Gufkral (Kajale 1982, Sharma 1982) and Burzahom (Vishnu Mittre 1974, personal observation) in Kashmir Valley also speaks for practice of double cropping pattern during the 1st millennium B.C. Although there is no detailed palaeobotanical report on Paiyampalli, Rao (1968) has mentioned the cultivation of cereals and pulses. He says 'charred grains identified as horse-gram (Khulti) and green-gram have been found in those levels, whereas few sherds of Megalithic pottery occurred on essentially Neolithic habitational deposits'. Subsequently Rao (1969) states that 'charred grains recovered from a large pit belonging to Megalithic period indicates the use of gram (Khulti), green-gram and cereal resembling ragi, all of which are grown even now'. This information has been excerpted from non-botanical notes presented by Rao and there appears to be some ambiguity regarding the use of common names and local names, e.g. gram is being equated with 'Khulti'. In fact the gram would botanically mean chick pea (*Cicer arietinum* Linn.) and 'Khulti' would mean horse gram (*Dolichos biflorus* Linn.). In view of the same, the findings from Paiyampalli are included in Table III with lesser degree of certainty and cannot be taken as botanically diagnosed ones. Rao's general interest in observing and announcing the evidence for plant remains is, however, appreciable. Plant remains from Gajjalkonda, District Kurnool and Fraserpet, District Koorg have been mentioned by Deo (1973) who states that 'at Gajjalkonda, pots in cairns were found to contain decayed grains while cromlechs from Fraserpet (Rea 1915) in Koorg yielded pots containing paddy husk as also ragi'. Such non-technical reports have limited utility, as unfortunately, there is no indication of species of grains in botanical sense and hence it is all the more difficult to guess whether they were domesticated or wild or intermediate forms. Such observations can, however, be useful in stimulating the specialists to undertake further scientific investigation. In resume, it may be surmised that the present study , besides providing very early evidence for pigeon pea has thrown important light on the richest sequential radiocarbon dated evidence for exploitation of wild and cultivated plant economy, food habits and continuity of double cropping right from Harappan (Late 3rd millennium B.C.) through Neolithic and Chalcolithic during 2nd millennium B.C. up to the Megalithic period in 1st millennium B.C. It also suggests possibility of intercropping during 1st millennium B.C. in ancient India. There is a mixed occurrence of grains of cereals and pulses in most of the samples but it is difficult to be certain whether this is an ultimate expression of multiple cropping existing then. The present study has also served to bridge the gaps in our understanding of farming practices of Late Chalcolithic and Early Historical periods in the Deccan and India in general. Besides,such studies can also be potentially useful to archaeologists for formulating socio-economic modelling of the past societies. All the materials (holotypes) are housed in Palaeobotany-Palynology laboratory of the Archaeology Department of the Deccan College Post-Graduate and Research Institute, Pune and are available for examination to other researchers.

Acknowledgements

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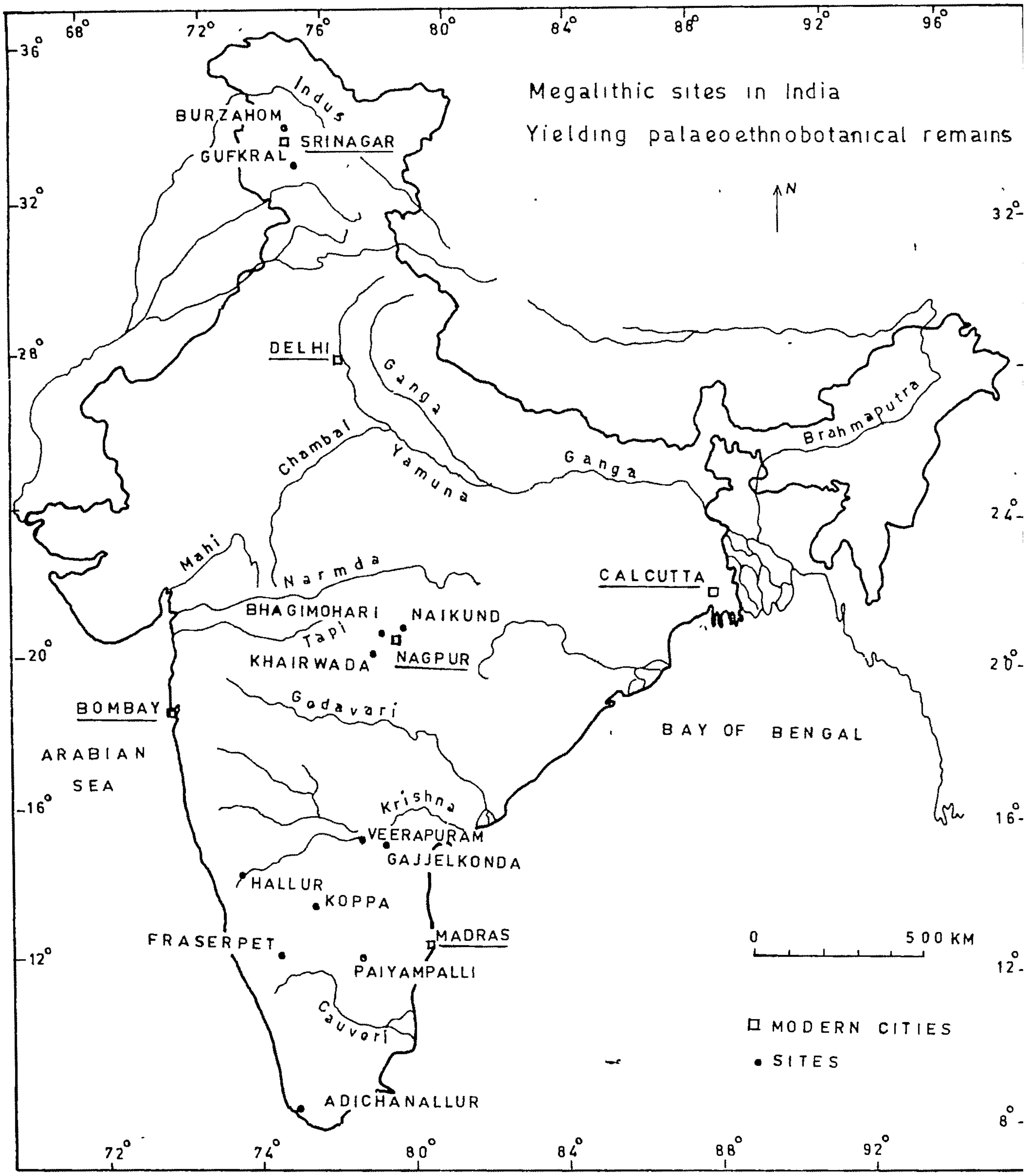
Explanation to Figures:

Fig.2 : (1) The habitational site at Bhagimohari before excavations, site encroached upon by the thorn and scrub vegetation,
(2) Excavated burial site (stone circle) yielding antiquities similar to those from habitational site,
(3) Excavation trench showing habitational levels from layers (1) to (9) and virgin black soil underneath the level (9).Habitational deposits show various carbonised bands which were the source of carbonised grains, charcoal woods and eventually radiocarbon dates,
(4) Manual searching of the antiquities by visual observation method,
(5) Wet Sieving (Flotation technique), 1st stage-pouring the representative habitational soil sample into the flotation sieve.

Fig.3 : (1) Wet sieving, 2nd stage-recovering the ancient organic assemblage,
(2) Wet sieving, 3rd stage-examining the residual mineral matter for clay lumps,potsherds bones, beads, etc.,
(3) Rice husk impressions and the husk remains preserved in clay lumps,
(4) Scooped out organic assemblage,
(5) Magnified view of the (9),
(6) Rice (*Oryza* cf *sativa* Linn.),
(7) Job's tears (*Coix lachryma jobi* Linn.).

Fig.4 : (1) Dorsal view of the barley grain (*Hordeum vulgare* Linn.),
(2) Ventral view of the barley grain (*Hordeum vulgare* Linn.),
(3) Black gram (*Vigna mungo* (L.) Hepper), entire grains and split cotyledons,
(4) Cotyledons from (3) showing radicle, plumule and also their impressions,
(5) Grass pea (*Lathyrus sativa* Linn.),
(6) Pigeon pea (*Cajanus* cf *cajan* Millsp. type) showing hylum scar,
(7) Pigeon pea (*Cajanus* cf *cajan* Millsp. type) showing general view.

Fig.5 : (1) Common pea (*Pisum arvense* Linn.),
(2) Lentil (*Lens esculenta* Moench.),
(3) Pigeon pea (*Cajanus* cf *cajan* Millsp. type),
(4) Hyacinth bean (*Dolichos lablab* Linn.),
(5) and (6) Indeterminate type, probably wild type,
(7) Indian jujube (*Zizyphus* cf *jujuba* Lamk.).


Megalithic sites in India
Yielding palaeoethnobotanical remains
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68°
72°
76°
80°
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28°
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12°
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74°
Indus
BURZAHOM
SRINAGAR
GUFKRAL
DELHI
Ganga
Chambal
Yamuna
Brahmaputra
Mahi
Narmda
BHAGIMOHARI
NAIKUND
Tapi
KHAIRWADA
NAGPUR
CALCUTTA
BOMBAY
Godavari
BAY OF BENGAL
ARABIAN SEA
Krishna
VEERAPURAM
GAJJELKONDA
HALLUR
KOPPA
FRASERPET
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500 KM
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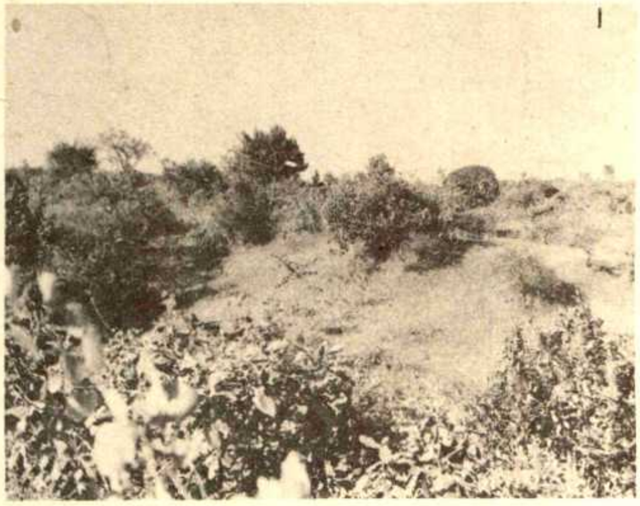
Fig.1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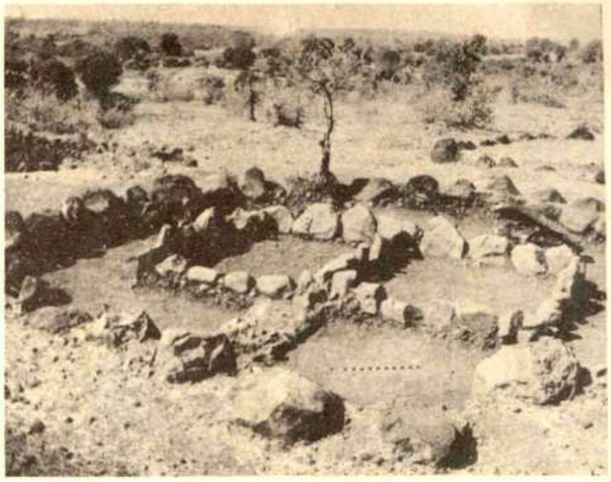
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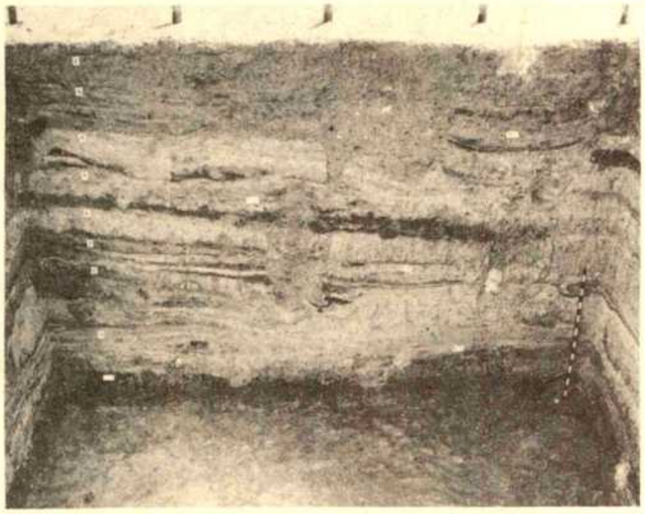
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Fig.2

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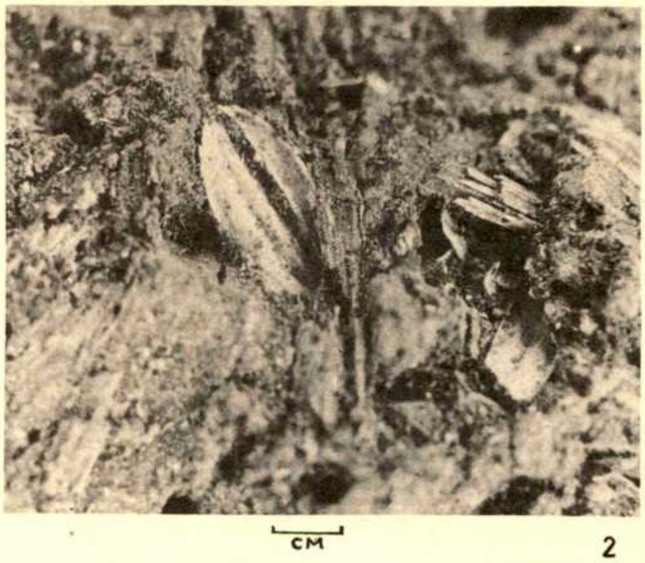

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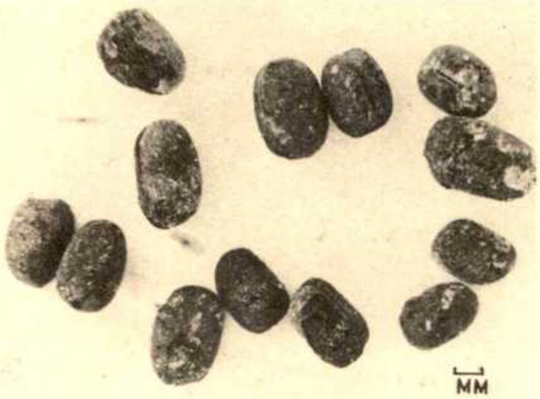

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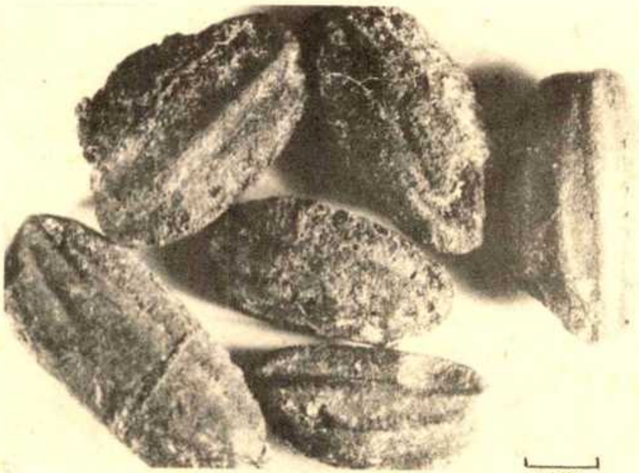

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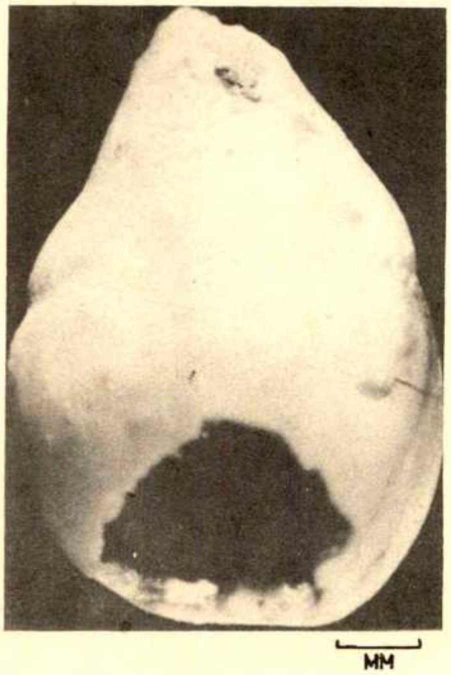

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Fig.3

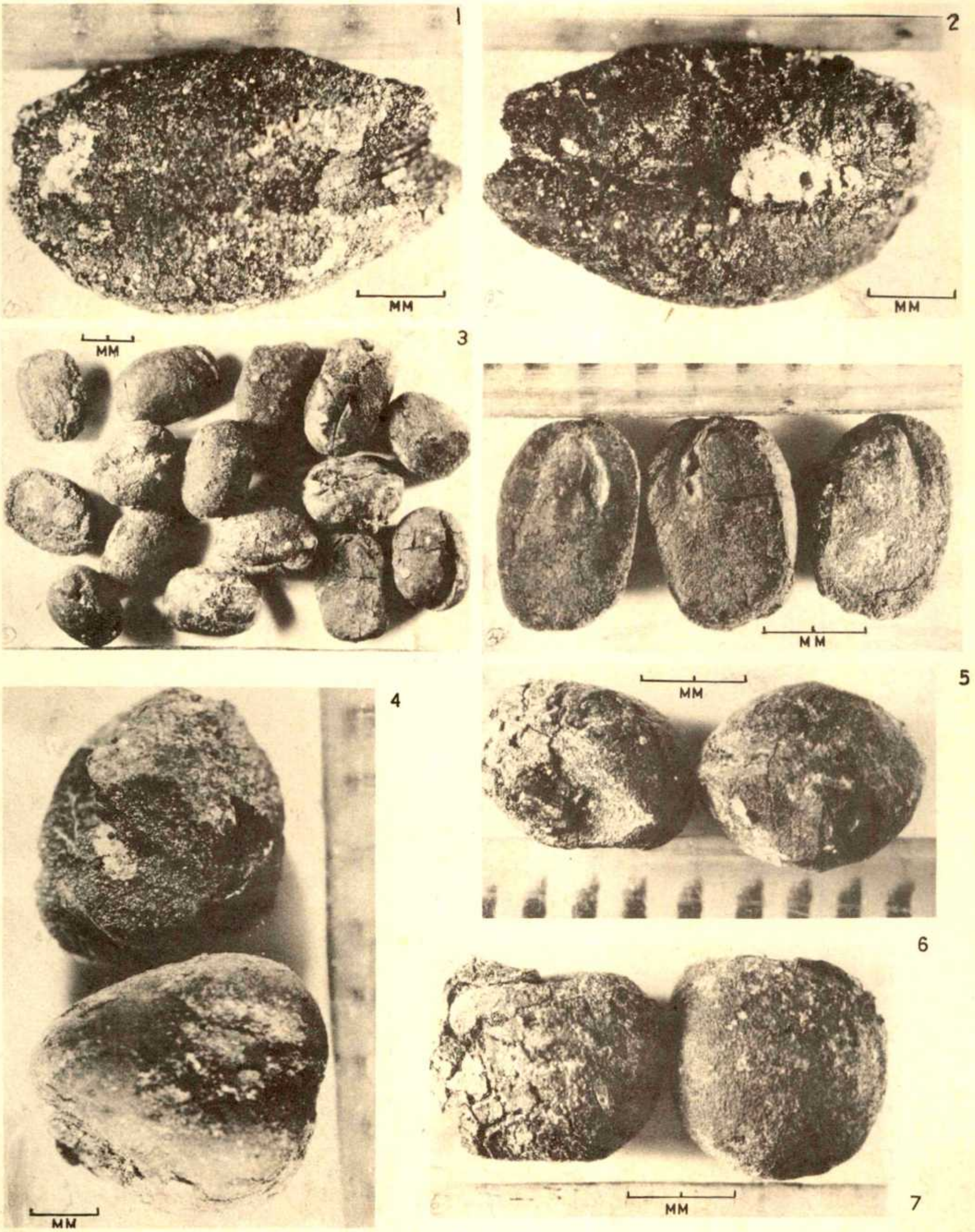


Fig.4

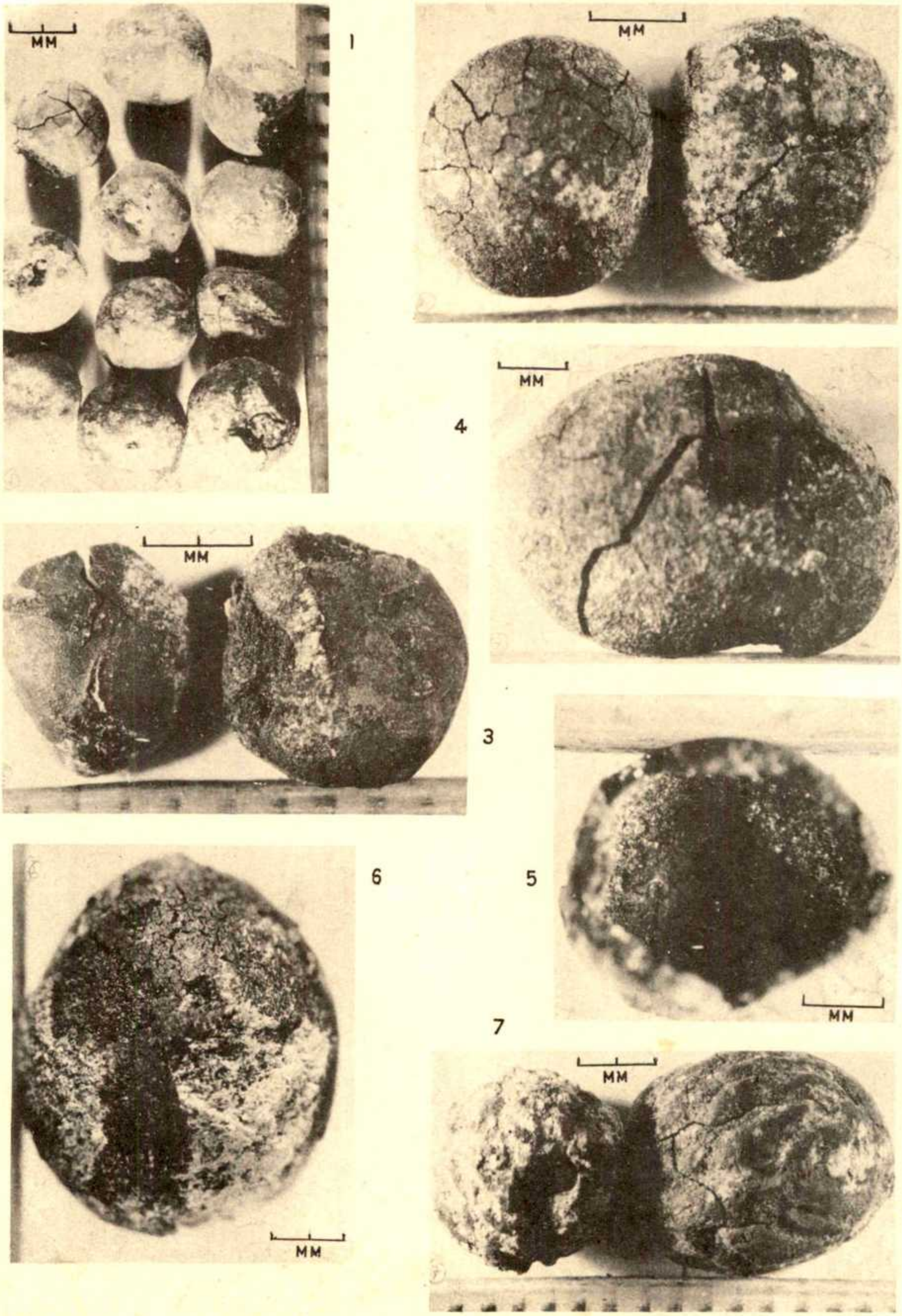
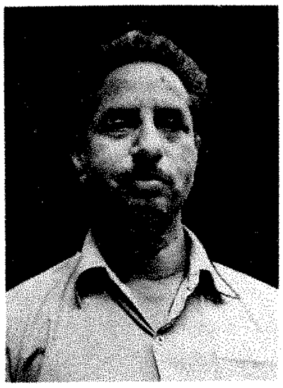


Fig.5

Obituary



Vishnu Shridhar Wakankar (1919-1988)

A tall, slim figure with rugged features, a weather-beaten but innocent and perpetually cheerful face, high forehead, sparkling eyes, a booming voice, dressed simply in *dhoti* or trousers, and a shirt and jacket, that was Dr. V.S. Wakankar, *Dada* to many of us who had the privilege of coming close to him. Although approaching seventy, he had an erect bearing and a zest for life that would do a young man of thirty proud. The moment you met the man, he claimed your full attention by recounting with his child-like and contagious enthusiasm his latest archaeological discovery or by discoursing upon a topic of current archaeological interest. He was bitten by a wander lust and spent most of his life exploring in the outback. So every time one met him, he had a surprise in the form of some new discovery up his sleeve. Wakankar was a man possessed by a burning zeal for unraveling his country's past. Anyone coming into contact with him could not fail to be captivated by his transparent sincerity and passionate devotion to Indian history and culture.

Born on fourth May, 1919 in a scholarly Brahmin family in Neemuch, Madhya Pradesh, Wakankar had a natural talent for art, specially painting, and he began making sketches both portraits and natural scenes from his school days. He had also a love for the outdoors and for travelling. The hills and forests of his home State inhabited by Bhils, Gonds and many other aboriginal peoples abound in caves and rock shelters formed by natural weathering of the soft sandstone rocks. Many of these were inhabited at one or more stages by Stone Age human groups who left a record of their existence in the form of plentiful stone tools, bones of the animals they hunted and ate, many other items of their use, and their own burials. But more than all this, these remote ancestors of ours profusely painted the walls and ceilings of their shelters with wild animals, hunting scenes, and activities of their daily life.

With his talent for painting and love for the countryside, it was only a question of time before Wakankar should come across these paintings. What accelerated the process was his early initiation into the Rashtriya Swayamsevak Sangh (R.S.S.). He was asked by the Sangh to do social and educational work among the aboriginal peoples. As the aborigines and the rock paintings shared a common environment, Wakankar got ample opportunity to pursue his love for exploring the rock paintings. And once he saw some of the paintings, he had found his vocation in life. For nearly fifty years he trekked through these forests discovering several thousand painted rock shelters, and making copies of the paintings. Rock art became his obsession and he wrote and lectured on it and exhibited it extensively, both in India and abroad. He published many articles both scholarly and popular and also the firstever book on the subject, the latter jointly with an American scholar, the late R.R.R. Brooks in 1976. In between he managed to acquire a diploma in Fine Arts from the J.J. School of Art, Bombay, completed his education up to M.A., and got a Ph. D. Degree in Archaeology from Poona University for his dissertation on the Prehistoric Art of India in 1973. Although prehistoric paintings had been discovered in India as early as 1867-68, perhaps for the first time anywhere in the world, they remained neglected by professional archaeologists. Wakankar's sustained research made this heritage of our country known to the world, and won respectability for this branch of archaeological study. Inspired by Wakankar's pioneering work, today a number of Indian and foreign scholars are investigating the field of prehistoric rock art.

Wakankar's love for the past was bound to extend his interest into other areas of archaeology. But there were few facilities in his home State for learning and practising more formal archaeology. The opportunity for him came in 1951 when Professor H.D. Sankalia of Deccan College, Pune began excavations at the early historic and protohistoric sites of Maheshwar and Navdatoli on the Narmada, south of Indore. Wakankar sought and immediately obtained Sankalia's permission to join the latter's excavation, and thus learnt the techniques of archaeological digging. Here he also got the opportunity to join the explorations for Stone Age sites in the Narmada valley, and learnt the rudiments of Quaternary Geology, Palaeontology, and typology and techniques of the tools of various stone ages. Subsequently he continued to increase his knowledge and experience by doing explorations and writing on them. When the late Mr. H.V. Trivedi, then Director of the M.P. State Department of Archaeology wanted to excavate the protohistoric sites of Awra and Manoti, he sought Wakankar's help. These opportunities gave Wakankar the confidence to conduct his independent excavations and explorations in later years.

This became possible when in the sixties the Vikram University at Ujjain put Wakankar in charge of the Excavation and Museum branch of its Department of Ancient Indian History, Culture and Archaeology. During the two decades or so that he held this position in the university, he excavated a number of archaeological sites of different periods in M.P. Important among these are the Chalcolithic sites of Kayatha, Azadnagar (Indore) and Dhangwada, and the Palaeolithic-Mesolithic site of Bhimbetka. The findings at the first three of these sites have thrown a flood of light on the first permanently settled inhabitants of the Malwa region whose economy was based on agriculture, and technology on stone and copper. The painted pottery and some of the copper tools found at these sites showed that these first farmers of Malwa were in some way inheritors of the legacy of the Harappan peoples of Gujarat. Wakankar's excavations in the rock shelters at Bhimbetka revealed a long history of occupation in these caves by Stone Age human groups. Wakankar conducted these excavations with the most meagre resources in money and man-power. He overcame these practical handicaps with his unbounded enthusiasm, indomitable spirit and commitment to research. It is doubtful that any other archaeologist would have been able to achieve so much with such limited resources.

Wakankar's academic interests covered not just prehistory and rock art but virtually every branch of ancient history and archaeology. These included Numismatics, Epigraphy, Palaeography, History and Sanskrit Literature. He was well versed in both Vedic and Classical Sanskrit Literature and the recitation of appropriate hymns and *slokas* came naturally to him while discussing archaeological and historical problems. His home in Ujjain which he turned into an Institute of Art and Culture has a vast collection of coins, manuscripts, paintings, art objects, and antiquities. Many years ago, the late R.R.R. Brooks, then Cultural Attache at the U.S. Embassy in New Delhi met Wakankar while on a visit to Ujjain. Wakankar invited Brooks to his home and the latter was as deeply impressed by the vast and diverse archaeological collections as by the varied interests and scholarship of Wakankar. This initial acquaintance developed into a deep mutual admiration and friendship. Over the next several years Brooks accompanied Wakankar to visit, explore and study cave paintings in the hills and forests of Madhya Pradesh, and the two together produced the first authoritative book on these paintings.

Wakankar's rich contribution to the study of Indian archaeology was well recognized and brought him many honours. He was invited to many international conferences on archaeology, and lectured in many Indian and foreign universities. Nearly two decades ago the State Department of the United States invited him at the instance of Mr. Brooks and Mr. Chester Bowles, the latter then U.S. Ambassador to India, on a lecture tour of the United States. His lectures were largely attended and appreciated, and one of them was presided over by Mrs. Dean Rusk, wife of the then Secretary of State. During this trip Wakankar visited many rock art sites in the States. and discovered quite a few new paintings. His discoveries were reported in Span, the magazine of the U.S. Embassy in India. The Government of India conferred on him the title of Padmashri in 1976. The Indian Society for Prehistoric and Quaternary Studies elected him its President in 1980.

Wakankar was essentially a self-taught archaeologist. He did not have opportunity for a formal education in archaeological excavation techniques and lacked the facility of a good library to keep him up-to-date in research methods, findings, and interpretative concepts. The quality of his excavations as also of his writings was not always up to the mark. His interpretations were sometimes biased by his nationalistic pride in Indian culture. He was essentially an explorer and his contribution to Indian archaeology lies mainly in his discovery of several thousand rock art sites and many protohistoric and historic sites.

Wakankar's human qualities were as impressive as his professional achievements. He was an utterly unassuming, simple and honest man, and liked to live an austere life. He did all his archaeological explorations on foot, carrying his equipment and personal belongings in a rucksack. He ate whatever food was readily available, and slept on the ground in any tribal hut, temple, or deserted place. Once while travelling by train between Bhopal and Itarsi he saw the impressive rocks of Bhimbetka from the train and got off at the small railway station of Barkhera to go and explore the rocks. Before venturing into the forest he buried some potatoes in the sand in a dry *nullah* bed and lighted a fire over them so that he would have the roasted potatoes for his meal after his exploration was over. In the forest he met a *Sadhu* (saint), Baba Saligram who had built a small temple in a cave on the Bhimbetka hill, and was living there. The *Sadhu* showed Wakankar many painted shelters and later accompanied him to the *nullah* in the valley. After seeing Wakankar eating his lunch of potatoes (*Alu*), the *Sadhu* named him *Alu Baba* and continued to address him by that name till the end of his life. Wakankar was equally at home with city people, the tribals and the villagers, and had a great respect for the unsophisticated simple people of the hills and forests among whom he spent most of his life.

Wakankar's enthusiasm for the study of the past was contagious and anyone who came into contact with him could not fail to be inspired by his example He was a born teacher, and was always eager to share his knowledge with anyone willing to learn. He was a generous and large-hearted man; pettiness of any kind was alien to his nature. He also had an implicit faith in human goodness, and trusted everyone he came into contact with. He was only too willing to let other archaeologists excavate the sites he had discovered, because he was interested in the growth of knowledge and not in personal fame. He invited Professor Sankalia and his colleagues at the Deccan College to excavate Kayatha and Bhimbetka, two of the most important sites discovered by him. While he too did excavation at these sites, he did not want any share in the work done there by archaeologists from the Deccan College While Wakankar was very proud of his Hindu culture, and was an active worker of the R.S.S. throughout his life, he was totally secular in his outlook. He had several Muslim students who were as devoted to him as his Hindu students.

The years did not dim his enthusiasm and dedication for the study of India's past. In 1985, at the age of 67, he led an expedition for the search of the lost Saraswati river, and trekked for several months across the desert in Punjab, Haryana, Rajasthan and Gujarat, studying the geomorphic vestiges of the river, and collecting folklore connected with it. His explorations received wide publicity in the popular press, and he lectured on them in many places.

During the last two years Dr. Wakankar was publicly felicitated by several organisations in Delhi, Jaipur, Bhopal, Bombay, Pune, Ahmednagar and other places. Although his health had slightly deteriorated and he had become frail, his enthusiasm for work remained undiminished. In the first week of April 1988 he had gone to Singapore to participate in the Pacific Hindu Conference. He died there on third April of a massive heart attack. The news of his sudden and unexpected death was received with total shock and disbelief by his thousands of admirers across the country and abroad. In August this year he was to participate in an International Conference on Rock Art at Darwin, Australia, and had been preparing an elaborate exhibition of Indian rock paintings for this occasion. Unfortunately, destiny deprived him of this opportunity.

The passing away of Dr. Wakankar has left a void in Indian archaeology and indeed in Indological studies in general which cannot be filled. In particular, it means a great loss to the study of prehistoric art. Dr. Wakankar will, however, be remembered for a long time to come for his manifold contributions to Indian archaeology as well as for the nobility of his character and personality.

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Obituary

D. Devahuti (1929-1988)

D. Devahuti (born May 1929) took her Degree of Master of Arts in History in 1950 from the East Punjab University. In the same year she married Shri Damodar Prasad Singhal. In 1956 she obtained her Ph.D. in Indian History from London University. Soon after, along with her husband, she moved to Singapore where Dr. Singhal was appointed as a Lecturer at the University of Malaya. In 1961 she accompanied her husband to Australia where the latter took up a position as Reader in Asian History at the University of Queensland, Brisbane. However, her love for her motherland and its history was so compelling that she decided to come back to India. She joined the History Department of Delhi University in the seventies as a Reader, later becoming a Professor in the South Campus of the same University.

Dr. Devahuti was an erudite and renowned scholar of Indian and Southeast Asian history. Her major interests were political and religious history, cross-cultural contacts, and historiography. Her *Harsha- a Political Study*, first published in 1970 and later in a revised edition in 1982, has long been a classic on the subject. Her other major work is *India and Ancient Malaya*. She also edited several volumes like *Problems of Indian Historiography, Bias in Indian Historiography*, and *Historical and Political Perspectives*.

She had her own view of Indian historiography. To promote it she collaborated with Dr. S.P. Gupta and other scholars in founding the Indian History and Culture Society some years ago. She took active interest in the growth of the Society and was its General Secretary for last few years.

Dr. Devahuti had a great love for, and pride in Indian culture, civilization and arts This admiration of the past urged her to travel widely in India and abroad She and her husband, both keen travellers, had visited almost all the countries like Egypt, Greece, Italy, China and Peru which had developed early civilizations

In recent years Dr. Devahuti, along with her husband, extended valuable intellectual, moral and financial support to Dr. S.P. Gupta in establishing the Centre for Research and Training in History, Archaeology and Palaeoenvironment, in New Delhi. After the untimely death of her husband two years ago, she assumed the directorship of the Centre. Her sudden and unexpected passing away is a great setback to the Society and the Centre.

In Dr. Devahuti's death the discipline of Indian History and Culture has lost a devoted and inspiring scholar. Those of us who knew her well will miss a very kindly and gentle friend and guide

Shashi Asthana

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MAN AND ENVIRONMENT

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4. Main headings and subheadings should be given on the left margin of the paper. The main headings should be marked bold and subheadings underlined.

5. TWO copies of the manuscript should be submitted. One of these will be sent to the referee and the other retained in the editorial office as a safeguard against loss/damage to the first copy.

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2. If you are quoting an author or referring to a specific point in his/her contribution, then the actual page number(s) should be mentioned so that the reader of your paper can locate and verify the reference cited. A colon should be used between year and page number (For example: Sankalia 1956:37).
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Lal, B.B. 1956. Palaeoliths from the Beas and Banganga Valleys, Punjab, Ancient India 12:58-92.
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Gaillard,C., D.R. Raju, V.N. Misra and S.N. Rajaguru. 1983. Acheulian Occupation at Singi Talav in Thar Desert: a Preliminary Report on 1982 Excavation, Man and Environment 7:112-130.

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Clark, J.D. 1985. The Microlithic Industries of Africa :Their Antiquity and Possible Economic Implications, in Recent Advances in Indo-Pacific Prehistory (V.N.Misra and P. Bellwood Eds.), pp. 95-104, New Delhi: Oxford-IBH.

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4. An abstract of the paper should be typed on the first page below the title of the paper and the name(s) of the author(s) and above the main body of the text.

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Indian Society for Prehistoric and Quaternary Studies

Man
and
Environment

Editors	V.N. Misra S.N. Rajaguru Statira Wadia	**Associate Editors**	Ravi Korisettar R.K. Ganjoo

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Editorial

With this issue of **Man and Environment**, the journal will be published twice a year, in June and December. Once again we would like to express our thanks to the **Ford Foundation**, New Delhi and especially to Shri V.C. Joshi and Dr. Tom Kessinger for the generous grant which has made this possible.

This might be an appropriate occasion to recall the circumstances in which **Man and Environment** was born. Immediately after the formation of the Indian Society for Prehistoric and Quaternary Studies in 1975, it was decided to publish a journal, and one of us (V.N. Misra) was asked to look after the editorial responsibility. Misra was, however, reluctant to proceed with the collection of manuscripts for publication as the Society had no funds at this stage to finance a journal. At this point, Dr. S.P. Gupta, who had been the main inspiration behind the formation of the Society and the decision to launch a journal, came forward to take care of the financial problem. He got the first volume printed by putting in his own money and enlisting the support of Mr. I.C. Mittal of D.K. Publishers and Distributors for printing and distributing the journal. In due course, the Society started getting financial support from the Archaeological Survey of India and the Indian Council of Historical Research. However, the journal would not have got started but for Dr. Gupta's zeal and deep personal involvement. We are sure that Dr. Gupta would feel happy that the Society is now in a reasonably sound financial condition, and the journal is being published twice a year and in a qualitatively improved form.

Beginning with Vol. XIII, the journal is being printed in Pune by Mudra. The quality of printing of this volume has won appreciation from all members and other readers. For his keen personal interest and active involvement we would like to express our gratitude to Shri Sujit Patwardhan, the proprietor of Mudra.

The world of Archaeology has mourned the passing away of Professor H.D. Sankalia. We felt that in the context of Indian Archaeology, Professor Sankalia's contribution has been so great that we should devote an entire issue to his memory. This issue will appear in December 1989. We have already contacted scholars whom we knew to have been associated with Professor Sankalia requesting them to send us their reminiscences, letters, photographs, etc. of Prof. Sankalia for inclusion in the memorial issue. Those scholars whom we have been unable to contact and who would like to contribute to this issue, should write to us for a copy of the circular as early as possible.

The present issue carries a number of articles (by V.N. Misra, M.L.K. Murty, M.K. Dhavalikar, R. Champakalaksmi, Shireen Moosvi, and Himanshu Prabha Ray) which were presented at a Discussion Meeting on the Ecological History of India held in the Centre for Ecological Sciences, Indian Institute of Sciences, Bangalore in February 1988. The Meeting was convened by Professor Madhav Gadgil and we are grateful to him for permission to publish the articles included here. Some of these articles deal with historical archaeology. They have nevertheless been included here because the Editorial Committee felt that they also contribute to our greater understanding of man's interaction with and exploitation of his environment. Though this journal is primarily concerned with prehistoric man and his environment, we feel that it should not close its doors, on purely technical grounds, to the study of the historical period or even of the present day environment where this helps to further our understanding of the past.

Dr. M.L.K. Murty who was Joint Secretary of the Society from 1981 to 1988 has recently moved from Pune to Hyderabad as a Professor in the Centre of Regional Studies in the University of Hyderabad. The Executive Committee and all members of the Society would like to gratefully acknowledge Dr. Murty's contribution to the smooth functioning and growth of the Society during the period of his association with it.

One of the ideas being discussed by the Editorial Committee is that from time to time we could devote an entire issue to a particular theme. In this connection we invite you to send in your ideas and suggestions.

We reiterate here that the success of the Editorial Committee's endeavour to improve the quality of this Journal in every respect is largely dependent on the active cooperation of its members. We therefore appeal to all members as also other readers of the journal to send us their research contributions for publication in **Man and Environment.**

Forty Years of Archaeobotanical Research in South Asia*

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There exits a close relationship between plant sciences and archaeology (Vishnu-Mittre 1968a). The study of plant remains from archaeological sites provides invaluable information on plant history, such as the use made of plants and their products by early man as well as his witting and inadvertent impact on their distribution and domestication through time. This branch of science is important to archaeology since it helps to reconstruct past environments, subsistence patterns, plant economy and the cultural interrelations of ancient peoples.

The study of plant remains from archaeological sites can most appropriately be called Archaeobotany. Some call it *Palaeobotany.* They may be right, but interestingly no textbook or reference book on Palaeobotany devotes a chapter or a section to the study of plant remains from archaeological sites. This may be because Palaeobotany is believed to be the study of plant remains from rocks while the sediments which comprise archaeological deposits are not natural but manmade. Or perhaps this is because the type of evolution in the plant world that a palaeobotanist is used to is not the same as that exhibited by the plant remains from archaeological sites. Others designate such a study as *Palaeoethnobotany.* Seemingly this appears to be quite adequate so far as the use of plants by man in the past is concerned. One important source for Palaeoethnobotany is indeed the plant remains discovered from archaeological excavations. But there is yet another source, the enormous amount of ancient literature with invaluable information on plants used by our ancestors. Most of this ancient literature dates from the Iron Age, i.e. after 1000 B.C. There is also Vedic literature, particularly the Rig Veda which may predate this period by about two centuries. Thus, palaeoethnobotany derives from literary as well as archaeological sources. In fact both the sources can be used to complement each other for a fuller knowledge of the subject. How very rich and useful the literary source can be becomes apparent after one goes through the publications of Gode (1945, 1946), Kosambi (1963) and Mehra (1967, 1970, 1975). Being a highly specialised field of scientific research, Archaeobotany deals with much more than merely the use of plants by early man. I, therefore, treat **Archaeobotany** as a distinct discipline rather than as a branch of Palaeobotany.

While pondering over an appropriate title for this Address, the current trend in the country to evaluate the progress of the last forty years came handy to me. However, looking back forty years to 1948, I found that no paper had been published on the subject in that year. I can therefore either commence this Address from 1946 when K.A. Chowdhury and S.S. Ghosh had published a paper on the plant remains from Arikamedu in Pondicherry or from 1950 when S.S. Ghosh published his discovery of a wooden post from Kirari in M.P. In either case it would not be forty years but 40± 2 years.

I have strong reasons for commencing this Address from the year 1946 rather than from 1950. The coconut is considered auspicious and is used to commence rituals and functions by a large majority of the people in our country. Remains of the coconut were discovered at the Indo-Roman site of Arikamedu in 1946. It seems auspicious, therefore, to review the work in Archaeobotany in the Indian subcontinent from the year 1946.

March of Archaeobotanical Research

Since the publication of plant remains at Arikamedu (Chowdhury and Ghosh 1946) work on the early and late Historical sites continued for nearly twentytwo years (Kirari:Ghosh 1950; Sisupalgarh : Chowdhury and Ghosh 1952; Hastinapur: Chowdhury and Ghosh 1955; Pataliputra: Ghosh and Lal 1958; Kalsi: Ghosh and Lal 1961; Prakash: Ramesh Rao and Shahi 1967; Kaundinyapura: Vishnu-Mittre 1966, 1968b). Along with these were a few references on archaeobotanical data from earlier cultures (Harappa: Chowdhury and Ghosh 1951; Chalcolithic Maski: Chowdhury and Ghosh 1957; Navdatoli: Vishnu-Mittre 1961; Iron Age Rangpur: Ghosh and Lal 1963) and also on silk and flax (Gulati 1961, 1965).

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*Presidential Address read at the XVI th Annual Conference of the Society held at Visva-Bharati, Santiniketan, West Bengal, December 1-3, 1988.

During the decade 1967-77 a great deal of work was carried out on the plant economies of cultures spanning 3-4 millennia from the Neolithic to early Historic (Vishnu-Mittre 1968b, 1969, 1971, 1972a; Allchin and Allchin 1968; Chowdhury *et al.* 1971; Vishnu-Mittre *et al.* 1972; Kajale 1976, 1977a-d ; Buth and Chowdhury 1971; Vishnu-Mittre and Savithri 1974,1975, 1978; Ramesh Rao and Lal 1985; Chowdhury *et al.* 1977). Within this period , 1974 stands out as a particularly significant year. To begin with it witnessed the publication of a comprehensive collation of all the available archaeobotanical records with a critical discussion of the same (Vishnu-Mittre 1974a) as well as a history of the distribution of individual crops in the Subcontinent (Kajale 1974). Maps based upon dated records of wheat and barley, of rice and of millets such as *Sorghum* (jowar), *Pennisetum* (bajra) and *Eleusine coracana* (ragi) from thirty archaeological sites in the Indian subcontinent make it easy to read diffusionary trends in these crops (Figs. 1,2, and 3).

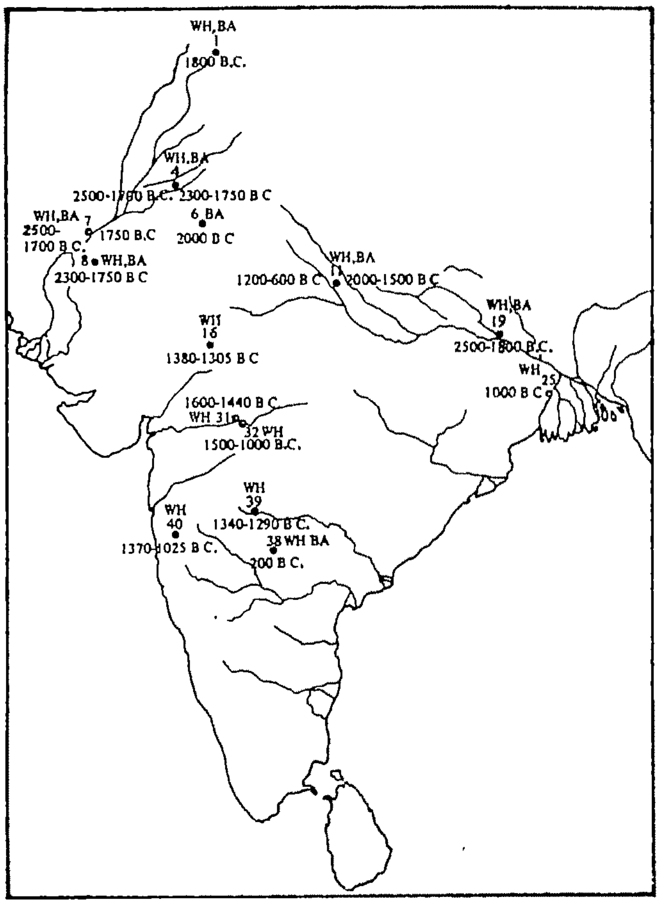

Fig.1. Geogrphical distribution of records together with dates of wheat and barley in the Indian subcontinent.

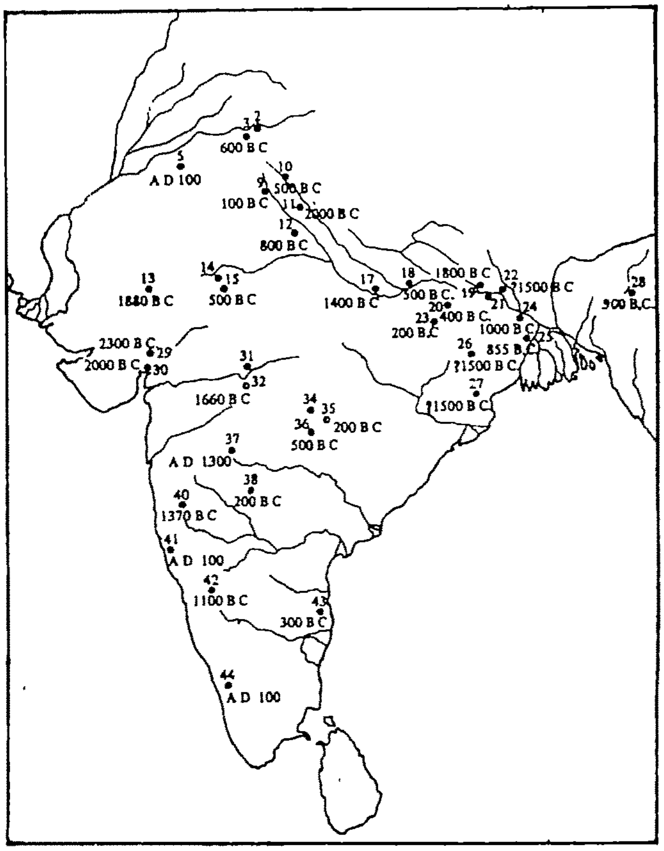

Fig.2. Geographical distribution of records together with dates of rice in the Indian subcontinent.

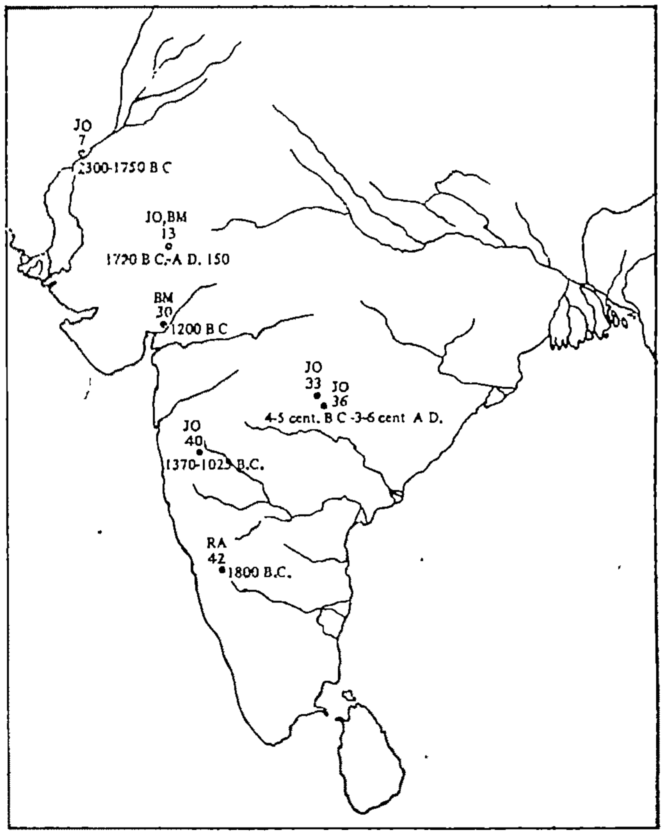

Fig.3. Geographical Distribution of records together with dates of millets in the Indian subcontinent.

Key to symbols for crops on Figures 1 to 4.

BA	Barley, *Hordeum*
BM	Bajra, *Pennisetum*
CA	Castor, *Ricinus*
CO	Cotton, *Gossypium*
DP	Date palm, *Phoenix*
HG	Horse gram, *Dolicos*
JO	Jowar, *Sorghum*
LE	Lentils, *Lens*
LI	Linseed, *Linum*
MA	Maize, *Zea*
MS	Melon seeds, *Cucumis*
MU	Mung, *Phaseolus*
PE	Peas, *Pisum*
PH	*Phyllanthus*
PS	*Paspalum scrobiculatum*
RA	Ragi, *Eleusine*
RI	Rice, *Oryza*
SE	Sesame, *Sesamum*
WH	Wheat, *Triticum*
WD	Weeds
ZI	*Zizyphus*

Key to sites plotted in Figures 1 to 4.

1. Burzahom
2. Kangra
3. Rupar
4. Harappa
5. Rangmahal
6. Kalibangan
7. Mohenjo-daro
8. Chanhu-daro
9. Khokhra Kot
10. Hastinapur
11. Atranjikhera
12. Noh
13. Ahar
14. Nagda
15. Garh Kalika, Ujjain
16. Kayatha
17. Kausambi
18. Rajghat
19. Chirand
20. Rajgir
21. Pataliputra
22. Oriyup
23. Sonpur
24. Mahisadal
25. Pandu Rajar Dhibi
26. Singhbhum
27. Baidipur
28. Ambri
29. Lothal
30. Rangpur
31. Maheshwar
32. Navdatoli
33. Bhatkuli (Amraoti)
34. Kaundinyapur
35. Pauni
36. Paunar
37. Nevasa
38. Ter
39. Sonegaon
40. Inamgaon
41. Kolhapur
42. Hallur
43. Kunnatur
44. Periyapuram

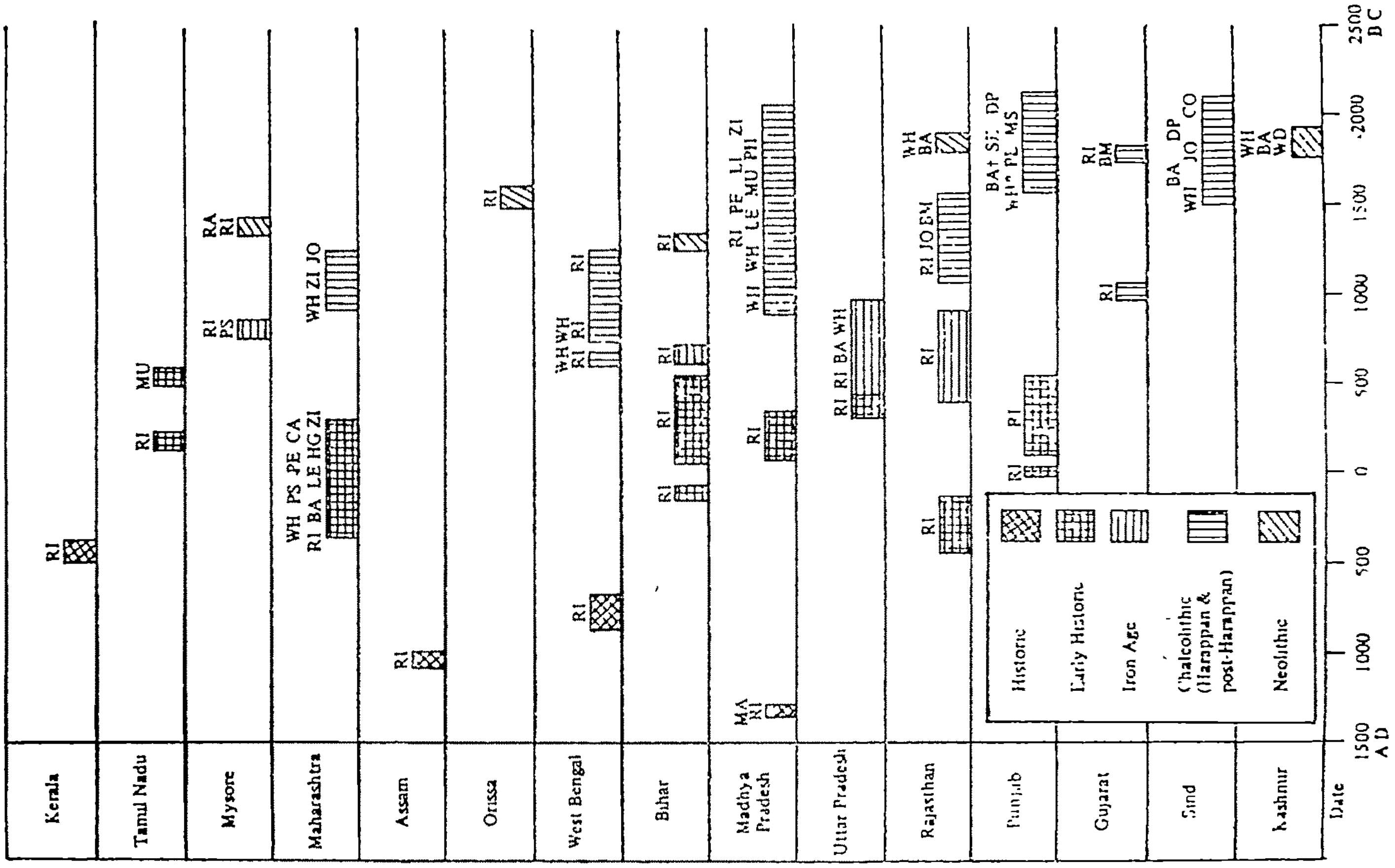

Fig.4. Distribution of cultivated plants in space and time in the Indian subcontinent.

Together with these maps a province-wise graphic distribution in space and time of 21 kinds of cultivated plants was also published (Vishnu-Mittre 1974c, Fig.4). A collation of records of cereals, and of timber plants, fibres and pulses was published by Chowdhury (1974a and b). Thirdly, Watabe and Toshimitsu (1974) worked out the alterations in time and space of rice grains from the then available archaeological evidence from the Indian subcontinent and thereby set a new trend for archaeobotanical studies in South Asia. A very important contribution indeed.

A serious stumbling block has been the difficulties faced in the reconstruction of the history of cereals in the Indian subcontinent. Neither the archaeobotanical evidence nor the recent age of our Neolithic permitted us to consider the origin of crops in the Indian subcontinent, and we had to content ourselves with the probability that the Subcontinent has been on the receiving end of the crops domesticated elsewhere. However, with regard to the origins of crops a ray of hope did exist in Vavilov's inclusion of the extreme north-western part of the Indian subcontinent in one centre and the rest of the Subcontinent in another centre. Whereas wheat, barley, etc. were believed by Vavilov (1951) to have originated in the former, rice was identified with the latter. In 1976 I had announced at the Royal Society, London, the world's earliest records of the evidence of rice in the Indian subcontinent (Vishnu-Mittre 1976).

The world's earliest evidence of domesticated rice *Oryza sativa* together with its wild annual (*O. nivara*) and perennial (*O. rufipogon*) progenitors was identified by us from husk imprints on the Koldihwa potsherds (Sharma, G.R. *et al.* 1980). The material recovered from the excavations, from strata below the levels dated by the C-14 method to 5440 ± 240 B.C.(PRL-100) and 4530 ± 185 B.C. (PRL-101) at the site of Koldihwa in the Ganga plains were sent to me for investigations. Prof. T.T. Chang of the International Rice Research Institute, Manila, Philippines, a participant in the London conference asked for the material for the SUMP studies. I am glad to say that he confirmed our identification of this revolutionary discovery in the Indian subcontinent. In certain quarters, however, its antiquity continued to be controversial.

The carbonised grains of barley from Mahagara, another site on the river Belan were dated to 7-6th millennium B.C. (Sharma, G.R. *et al.* 1980), and have been described in detail (Sharma, A. 1985). This discovery stimulated further thought on the origin of rice in areas outside or on the fringes of T.T. Chang's Primary Area for its origin (Glover 1985).

Close on the heels of this very important discovery from e Ganga plains, a French team led by Jarrige discovered a ery old Neolithic site at Mehrgarh in Baluchistan (Jarrige 979; Jarrige and Lechevallier 1979). The results of xcavations at this site have proved exceedingly interesting arrige and Meadow 1980; Jarrige 1982). *Triticum onococcum, T. dicoccum* and *T. durum/aestivum* together ith barleys have been dated to the 7th millennium B.C. At is site evidence of the above crops continues through the h and 5th millennia when cotton seeds are also found. By e 4th millennium B.C. there is the evidence of wheat *riticum sphaerococcum*). Comparatively speaking at the rliest Neolithic site in the Ganga plains evidence of ultivated rice with wild progenitors has been found and these ccur there and in other parts of the Indian part of the ubcontinent even today. The eincorn (*Triticum onococcum*) and the emmer (*Triticum dicoccum*) wheats are nknown in the Indian subcontinent as a whole. Several wild pecies of *Agropyron* previously referred to the genus *riticum* and a single species of *Aegilops* (*A. tauschii*) occur Baluchistan and in other parts of what is now Pakistan. ome species of *Agropyron* also occur in India. Some species wild grasses belonging to the two genera *Agropyron* and *egilops* are believed to be progenitors of wheats. Several ild species of *Hordeum* including *H. spontaneum* are elieved to be the progenitors of cultivated barley. They ccur in Baluchistan and other parts of Pakistan and India. ther interesting publications of the year 1979 are a omprehensive study of the seed remains of ragi (*Eleusine racana*) (Savithri and Vishnu-Mittre 1979) and reports on e plant remains from Pirak (Constantini 1979) and from pegaon (Kajale 1979).

The present decade has produced equally valuable rchaeobotanical work. The antecedents of the Indus Valley ivilization in the Mehrgarh finds were published by Jarrige nd Meadow in 1980 followed shortly by a paper by Jarrige 1982 on the significance of Mehrgarh excavations in the rehistoric context of the Indo-Pakistan borderlands. A etailed report on the food economy of the Harappans ppeared in 1982(Vishnu-Mittre and Savithri 1982). Kajale 982a) has presented a report on Gufkral in Kashmir and on eerapuram (Kajale 1984) in Andhra Pradesh. The year 1982 ad also witnessed the publication of plant economies of emthan (Buth *et al.* 1982) in Kashmir and of the megalithic te of Naikund in Maharashtra (Kajale 1982b).

From 1975 there has been a growing emphasis on the nportance of ethnobotanical studies by archaeologists to the terpretation of man-plant relationships (Nagar 1975, 1985; urty 1985). It must be specially mentioned that Vishnu-ittre (1985) and Mehra and Arora (1985) have compiled the vailable ethnobotanical data for ready reference and use by rchaeologists. The year 1985 also witnessed publications on lant remains from Burzahom (Buth and Kaw 1985) and from early Historic site, Narhan (Saraswat and Sharma 1985).

The year 1986 may be considered a record year. Buth and Lone and Khan published several papers during this year. Besides these, comprehensive reports on the Daimabad plant remains (Vishnu-Mittre *et al.* 1986), on the Harappan plant economy at Rohira, Punjab (Saraswat 1986a) and on the Iron Age plant remains from Sringverpura (Saraswat 1986b) also appeared. In the same year Possehl (1986) published the history of African millets in South Asia.

In 1988 Kajale published a paper on the plant remains from Chalcolithic Tuljapur Garhi and a comprehensive report on the plant economy from the Chalcolithic site of Inamgaon in Maharashtra (Kajale 1988a, 1988b). Much unpublished work is locked up in Ph. D. theses on archaeobotany (Savithri 1976; Sharma 1985; Chanchala 1984; Lone 1987; Khan 1987). It is hoped that in the coming years their publication will augment our knowledge of archaeobotany in the Indian subcontinent.

An important archaeobotanical discovery in Kashmir, is the recovery of charred remains of the Chinar (*Platanus orientalis*) from the Megalithic period. This sets to rest the theories of its introduction into the Valley during the Mughal period (Lone *et al.* in press). This is a solitary example of the introduction of an exotic plant in Indian archaeobotany even though there are numerous instances of the import of timber from diverse climatic regions within the Subcontinent (Vishnu-Mittre and Chanchala 1983).

During the last forty years there have been numerous attempts to recover pollen from archaeological sediments. The first attempt was made by me in 1957 (Vishnu-Mittre 1957). It was followed by Guinet(1966), Singh (1970), Van Zeist (cf. Paddayya 1977) and Pant and Pant (1980), all of whom reported pollen grains in only one or two samples. I also examined numerous samples from several sites and some from profiles. Insufficient pollen was found in these sediments for analysis. Generally, pollen analysis of archaeological sediments in the Subcontinent has not proved fruitful and successful.

Among the advanced techniques used in the identification of imprints and carbonised grains , special mention may be made of the application of SEM. The first attempt was made by T.T. Chang on rice imprints on Koldihwa potsherds and opened up new vistas for research. Buth and Bisht (1981) used SEM in the study of ancient wood remains from Kashmir and Buth (1986) used it in the identification of grains of wheat. Aruna Sharma (1985) used it extensively in her Ph.D. thesis and some results have been published (Dixit *et al.* 1987). Khan (1987) has also intensively made use of SEM in his archaeobotanical studies so has Lone (1987). This is indeed a progressive and encouraging trend in archaeobotanical research in South Asia.

Quantitative Evaluation of Progress

There now exists a large body of published material on the archaeobotany of South Asia. This has appeared in a wide variety of professional journals. Archaeobotany has obviously stimulated interest among specialists of varied disciplines.

The history of agriculture by the late Dr. M.S. Randhawa (1980,1982,1983) provides information on past agriculture based on archaeological plant remains. Information on modern crops has been published by Indian agriculturalists in Hutchinson (1974).

During the last forty years plant remains from 106 archaeological sites have been described from the Indian subcontinent. However, eight of these (Aligrama, Balakot, Chanhu Daro, Loebanr III, Mehrgarh, Mohenjo Daro, Mundigak and Pirak) are now in Pakistan. Plant remains from the following 24 sites have been partly published:

> Ahar, Burzahom, Chirand, Dadupur, Daulatpur, Gufkral, Hallur, Inamgaon, Kalibangan, Khairwada, Koldihwa, Mungi, Kawson, Nagara, Nevasa, Paithan, Rupar, Semthan, Sonegaon, Surkotada, Tekkalkota, Tripuri, Un, and Veerapuram.

From the following 22 sites plant remains still await publication:

> Baranuha, Besnagar, Dangwada, Eran, Hulas, Kakoria, Kayatha, Kunjhun, Lahura deva, Lekhahia, Magha, Mahagara, Mahisadal, Manigara, Purana Qila, Rajgir, Ramapuram, Rojdi, Runija, Singh Bhagwantpur, Sangankallu, and Sohgura.

Altogether there are 194 plant species identified from archaeological sites. Plant remains comprise charcoal, carbonised seeds and fruits and their compressions and impressions (particularly of husk).

There are 81 species identified from charcoals, 67 from wild seeds and fruits, and 46 from seeds and fruit remains of cultivated and/or planted species. A comparative study of these species shows that there are three plant species which are found both as seeds as well as charcoal. These species are *Celtis australis*, *Juglans regia* and *Vitis vinifera*. The last two species occur both wild as well as from planted remains. Some species are also planted ones even though they occur wild in the Subcontinent. The significance of this is discussed elsewhere in this Address.

There can hardly be any comparison of the archaeobotanical work during the last forty years with that accomplished during 1931-1945. Prior to 1946 plant remains were known only from four sites - Mohenjo Daro, Chanhu Daro, Harappa and Khokhrakot (Vishnu-Mittre and Savithri 1982) as against 106 sites from which plant remains have been described subsequently. Only nine plant species were identified before 1946:

> *Triticum compactum, T. sphaerococcum, Hordeum vulgare* var *nudum, H. vulgare* var *hexastichum, Oryza sativa, Pisum arvense, Brassica juncea, Sesamum indicum, Phoenix dactylifera.*

In the subsequent years, two more species of wheat and barley, one of oats (*Avena* sp.), six kinds of millets and maize (*Zea mays*), were identified of which the last three cereals were not known before. Likewise against one legume then known, twelve more have been added. Against date palm and sesame, eleven more cultivated plant species have been added which are fibre, oil, spice and fruit crops. Against one wild and cultivated species *Brassica juncea*, there are 67 wild plants species known today and some nine species are cultivated. Charcoal studies were not conducted prior to 1946. These studies have greatly added to our knowledge of nearly 80 arboreal and shrubby plants used for various purposes in the past. Even though we have a few pollen analytical studies of archaeological sediments during the last 40 years, no such study was attempted prior to 1946.

Archaeobotanical Centres

The Wood Technology Branch of the Forest Research Institute, Dehra Dun, continued for many years as the only centre for archaeobotanical research. Here, the work was carried out by Professor K.A. Chowdhury and Shri S.S. Ghosh. After the sad and untimely demise of Shri. S.S. Ghosh and the superannuation some years later of Prof. Chowdhury, this centre was adversely affected. The work thereafter limped along under Ramesh Rao and his colleagues.

The Botany Department of the Aligarh Muslim University emerged as a new centre, after Prof. K.A. Chowdhury accepted an assignment there. But work continued here for only a couple of years.

In 1960 the Birbal Sahni Institute of Palaeobotany commenced work on archaeobotany in the then Department of Quaternary Palynology with the blessings and patronage o our most revered Professor H.D. Sankalia. Soon thereafter the Archaeological Survey of India extended its cooperation to the BSIP. Professor B.B. Lal, Shri M.N. Deshpande and Shri B.K. Thapar, all former Director Generals of the ASI, as well as several other officers namely Shriyuts N.R. Banerji, J.P. Joshi, K.N. Dikshit, S.A. Sali and several superintending archaeologists in several States, professors and Heads of Departments of Ancient Indian History and Archaeology e.g. Professors B.P. Sinha, G.R. Sharma, V.S. Wakankar to name a few have been extremely kind in helping this Centre with materials and literature. I am also grateful for their courtesie and to the foreign colleagues who not only visited this Centre but sent materials for investigation for example, the Allchins, Prof. W.G. Solheim, the late Dr. Chester Gorman and Professors Dupree and Zide. More recently the collaboration has been with Prof. G.L. Possehl. The collaboration and cooperation has been immense and the work produced was well-received with the result that the Governors at the Institute approved my suggestion to re-christen the erstwhile Department of Quaternary Palynology as the Department of Quaternary Biogeography and Archaeobotany. I trust that this Department and the Centre of Archaeobotany created by one will grow from strength to strength.

The Archaeobotanical Laboratory at the Deccan College was set up in the early seventies. The young and energetic Dr. M.D. Kajale has indeed been doing very valuable work here. This Centre has the advantage of the availability of materials as a result of the active excavation programmes of the Institute.

Very lately the Department of Botany of the Kashmir University has emerged as another centre of research on archaeobotany. This Centre has been initiated by Dr. G.M. Buth, a former pupil of the late Prof. K.A. Chowdhury. mportant work on the archaeobotany of the Kashmir Valley, Burzahom and Semthan) has been accomplished here.

The emergence, growth or extinction of an archaeobotanical centre is dependent upon the patronage eceived from excavators or the ASI without which it cannot survive. This patronage is its life-line. If a centre is set up for an individual expert, it will continue to exist so long the expert remains there and will probably not survive much after the expert leaves as happened with the Dehra Dun centre. A centre may be strangulated to death, expert not withstanding, if this patronage is withdrawn, the Kashmir Centre is an example. It would be indeed unfair to Archaeobotany to continue patronage to a centre where experts no longer exist. There are certain other factors which may govern the existence or extinction of archaeobotanic centres. There are professional jealousies, provincial, caste or creed considerations all of which may either strangulate the centre and talented experts or uplift both to international levels. These factors unfortunately have plagued our research institutions and crushed scientific talent.

Some Grim Realities Ignored

A critical appraisal of the last forty years of archaeobotanical research, both from a qualitative and quantitative point of view will show the extent of progress made in this field. However, I feel it is important to draw the attention of my fellow archaeobotanists and archaeologists to some of the realities involved in the study of Archaeobotany.

Indeed there is probably a general awareness of the difficulties involved in running down an identification to a genus or a species inspite of the fact that the identifications have been based upon modern comparative materials. However, such complexes as *Phaseolus/Vigna, Triticum durum/aestivum/compactum* have remained unresolved. Having been primarily involved in effective identification not only was progress in taxonomy overlooked but also the experiences of the earlier workers in this field. Furthermore the identification of certain grains to species which are not indigenous but exotic, though introduced into the Subcontinent, such as *Phaseolus vulgaris, Phaseolus lathyroides*, etc. reveals negligence on the part of some colleagues as well as the unsuitability of their Modern Comparative Database. Frequent checking of botanical names is as important as effective identification.

We would do well to take note of Howard's experience with grains of modern wheats. He found a baffling array of intermediates between species and interestingly he found that based upon glume and grain shape the specific distinctions broke down (Howard 1916). I also wish to draw attention to the divergent views expressed by Percival (1921), Stapf (1931) and Burt (1941), on the identity of carbonised grains from Mohenjo Daro and other Harappan sites. Van Zeist's opinion which is most recent, is that one cannot distinguish tetraploid wheat from hexaploid wheat on the basis of carbonised grains. In nature, the three rices, the cultivated *Oryza sativa* and its two wild progenitors, hybridise so freely that they produce swarms of intermediates. That this happened in the past too cannot be ruled out. The identifications seem to have been done in complete disregard of the range of variations that occur in these and other plant species. Not only is this aspect completely overlooked but also the large number of measurements taken are given in tables of modern and carbonised grains without computing some measure of variation. At least a simple standard deviation should have been used to ascertain whether the differences are real or not. In wheats particularly, it has not been realised that the size and shape of grains vary with their position on the spikelet or with the position of the spikelet on the head. The entire range may occur in a single plant. Further, statistical comparisons have been made between a large number of modern grains with those based upon a few carbonised grains. And yet no efforts have been made to artificially carbonise comparable modern grains to learn the extent of reduction in the size of these grains.

The situation in the identification of the seeds of wild plants is more precarious than that of the seeds or grains of cultivated plants. What is needed most is the preparation and publication of illustrated regional seed catalogues or seed manuals as ready references for identification together with modern seed collections. To recover a substantial amount of seeds it is very important that archaeological sediments, in bulk, are subjected to the flotation process.

An archaeologist generally gathers all the charcoal available from all the cultural levels, packs them properly and sends the entire lot for C-14 dating. He does, however, indicate the most important ones to be dated. Perhaps he believes that charcoal is only meant for dating. According to the usual practice of dating samples in C-14 laboratories and owing to the high cost involved, the in-charge of the laboratory dates only a few of the indicated samples. The remaining samples are registered in the laboratory but they are not returned if undated, nor are they sent to any other type of analytical laboratories and as a result lie wasted.

The charcoal samples are derived from the timber of trees which early man had gathered and used. A study of their internal structure when compared with samples from similar modern examples helps us identify the various species exploited by early man. It is important to try and retrieve from C-14 laboratories, charcoal samples which will not be dated; because with the help of that branch of botany, known as Xylotomy, we are able to greatly increase our knowledge of the environment and climate prevailing at archaeological sites during prehistory. Eighty plant species have been identified from charcoal samples from archaeological sites. Of these half were identified from the charcoal samples retrieved from various radiocarbon dating laboratories. The samples retrieved from the TIFR and BSIP Laboratories were originally obtained from the following sites: Ahar, Besnagar, Burzahom, Eran, Gufkral, Hallur, Inamgaon, Kalibangan, Kayatha, Lekhahia, Nagara, Ramapuram, Rojdi, Rupar, Sangankallu, Singh Bhagwantpur, Sonegaon, Tekkalakota and Veerapuram. One can imagine what a loss it would have been to our knowledge of archaeobotany if the above materials had not been retrieved and investigated. Excavators are urged to see that all types of material of plant origin discovered by them are examined by a trained archaeobotanist.

I have referred to the few attempts to analyse the pollen from archaeological sediments as currently available in print. A lot more samples were, however, pollen analysed by me at the request of several of my friends because they were interested to learn about the then prevailing environment and climate at these excavated archaeological sites. I have also analysed samples collected from exposed sections along the Narmada, Son and Belan rivers. Samples from cave deposits have also been sent to me. I have often discussed with friends in archaeology that these sediments are either devoid of pollen, or if present, it is not sufficient for frequency calculations. Even if a count of 200 is achieved by counting all the pollen in a given sample, it would not be worth it, because the proportional destruction of pollen in archaeological sediments, makes them unsuitable for pollen analysis. Bulk maceration to recover pollen from archaeological sediments was also suggested. However, most archaeologists do not realize that pollen analysis is normally applied to fine grained lacustrine and fluviatile sediments. All archaeological sediments therefore do not qualify. The ideal sediments are growing geological deposits of all kinds, such as lake muds, peat bogs, salt marshes, etc. It is only when pollen grains incorporated in natural sediments are recovered and studied that it is possible to reconstruct a broad picture of the past vegetation and to provide a generalised time scale of wide applicability.In these natural deposits there is usually small or insignificant post-depositional destruction of pollen unlike in archaeological sediments. Turner (1975:290) is of the opinion which also reflects the general consensus of leading pollen analysts that: "...flotation methods are normally used in pollen analysis of loesses or cave deposits, where it is recognised that the original rate of sedimentation of pollen was very low. The uncritical use of such methods on sediments where the low pollen frequency is due to post-depositional destruction can only give rise to misleading results and bring this whole method of analysis into disrepute. In this case there seems little doubt that it is better to rely on the faunal and geomorphological rather the palynological evidence in assessing the age and climate..."

Interpretive Strategies

Authentic identification of plant remains, secure isotopic dates and dependable archaeological provenance contribute greatly towards the success of archaeobotanical research. More often than not the evidence comprises only plant remains and consequently the only reasonable inference that can be drawn from its occurrence in an archaeological context is that it was gathered by early man and used by him. The presence of carbonised wheat or rice grains may suggest that it was cultivated or wild but this evidence does not prove that it was cultivated by the people living at the site since they may have gathered or acquired it from elsewhere. Likewise a piece of charcoal from an archaeological site might suggest that wood was used as fuel. It is in this respect also that the evidence can be made use of in building up our knowledge of past man-plant relationships. More thorough scientific investigation will help the researcher to reconstruct and interpret the evidence without much use of assumptions, presumptions and imagination or all these to the extent where the imagination runs wild and inferences and interpretations become ridiculous. In addition to these three situations, there is the fourth one where a researcher is inspired to jump to conclusions before complete information on the evidence has been obtained. There is yet another, where the other sources of information are not consulted and their importance not realised.

It can be seen from the archaeological reports published on various archaeological sites that the evidence has been used towards the reconstruction of local and regional plant economies. In addition all the data from the Subcontinent has been evaluated in both time and space to build up changing patterns in plant economy as a consequence of intra-Subcontinental diffusion of crops replacing the erstwhile major staples. An example of this would be the spread of rice from the Ganga plains across Central India to South India where it tended to replace the wheat-barley and millet economies by a rice dominated economy (Vishnu-Mittre 1977, 1978). Likewise is its introduction into the wheat-barley economy in the Kashmir Valley as discovered recently by Buth and others (1986a).

Continuing with the origin and history of crops outside the Indian subcontinent and in the world context, our discussion and approach are strongly influenced by Vavilovian concepts (Vavilov 1951) and later developments in this regard. Even though we pride ourselves in having the oldest or one of the oldest civilizations in the world, we now learn that wheat and rice which we have almost revered and used in our rituals and customs together with several other crops which we have grown since time immemorial, are not our own. Giving a recent version of the Vavilovian concepts, Whyte (1985)from his re-examination of the situation on the origin of crops of South Asia would have us content ourselves with the unwelcome but seemingly true views that the Indian subcontinent has been on the receiving end our modern and ancient crops are of Western, African and Southeast Asian origin. Maize, however, probably found a secondary centre in Assam after having been introduced by the Spanish voyagers from Mexico via the Philippines into South China and therefrom to India. Based upon Indian and other evidences the Pre-Columbian introduction of maize is strongly supported by Marszewski (1975, 1978).

The progenitors of *Eleusine coracana* (ragi) have now been discovered with the world's oldest record of ancient ragi in India (Dixit *et al.* 1987). *Cajanus cajan* (pigeon pea) is now on its way to emerging as a strong candidate for India's contribution to the world food economy. With further evidence *Echinochloa frumentaceum* and *Paspalum scrobiculatum* will perhaps qualify for the same category. If, this should be confirmed (Glover 1985; Chang 1989) the fairly early records of wild and cultivated strains of rice dating from the 7-6th millennia B.C. from Koldihwa are the other candidates. More or less contemporary records from Mehrgarh of *Triticum monococcum* and *T.dicoccum* and later the hexaploid wheat (*T. sphaerococcum*) like that of rice records tell the same tale. The picture that is emerging from these discoveries suggests that the Indian subcontinent belongs to two centres for the origin of crops (Vavilov 1951). We need to intensify archaeobotanical researches to settle the issues which continue to influence our thinking on for instance the African origin of millets in India (Possehl 1986) or the baffling situation created by our discoveries of some millets (ragi) with very ancient records (Hutchinson 1974).

The origin and history of crops has inadvertently been equated with the origin and history of agriculture and often discussed under this title (Vishnu-Mittre 1968a; Constantini 1984; Sharma, G.R. *et al.* 1980; Buth *et al.* 1986b). Archaeobotanical research has inspired, through new finds, the successful search for past occurrences of mixed and double cropping patterns (Kajale 1977b, 1988a and b; Fentress 1985), the use of fertilizers (Vishnu-Mittre and Savithri 1982), the various early subsistence patterns (Dhavalikar 1985; Dhavalikar and Possehl 1974), the exchange patterns between the hunter-gatherers and the early agriculturists (Allchin 1977; Possehl 1979; Possehl and Kennedy 1979) and the processes and trends in domestication (Vishnu-Mittre 1985; Mehra and Arora 1985; Chatterjee 1985).

While dealing with charcoal it should not be overlooked that they are the remains of the selective exploitation of trees or shrubs occurring within and/or outside the forest. The immediate inference drawn from the botanical identification is that of the habit (tree, shrub or tall herb) and then habitat of the plant i.e. whether it occurred in or along a water body or river bank; on sand, sandy shores or sand dunes; on hills, in valleys, in a plant community or in the open. This last evidence is reconstructed by studying all the charcoal from an archaeological site and then comparing them with the existing situations. This leads the researcher to conclude that the past climate and environment of a site were much as they are at present(Seth 1962, 1978; Chowdhury and Ghosh 1951; Vishnu-Mittre 1974b and c). In other words, the evidence from a study of charcoal does not suggest a change in climate, it tells of the habitat.

Often charcoal identified at a site may belong to a number of plant species belonging to diverse habitats and different climatic regimes such as the occurrence of solely Himalayan species (e.g. *Cedrus deodara*, *Ulmus* sp. and *Pinus roxburghii*) at sites located far away from the Himalayas as at Ropar, Atranjikhera, etc. The occurrence of species of restricted distribution e.g. *Dalbergia latifolia* (South India) and *Dalbergia sissoo* (North India) together at a site in the north would suggest that the timber of *D. latifolia* was brought to the north. Similarly the timber of Himalayan plant species was brought to sites in the plains of Punjab and U.P. leading to the additional inference that ancient peoples - the Harappans, Chalcolithic or OCP people were adventurous or else they had trade contacts with peoples living in different regions. Also that they knew the utility and property of the timbers of various speciesis another plausible inference.

At Daimabad for instance we (Vishnu-Mittre *et al.* 1986) had identified three groups of charcoal representing three ecological components viz. a dry deciduous, a moist deciduous and an evergreen. Species of thorn forest still occur in the vicinity of the site which now has a semiarid climate, but neither the moist deciduous nor the evergreen type of trees occur. These two components occur 100-300 km west of Daimabad and they have probably been growing there for the last 4000 years since the initial occupation of the site, as no drastic change in climate has occurred during this interval and the vegetational belts have remained unaffected (Vishnu-Mittre 1983:117-119). Trends towards degradation of forests as a consequence of excessive exploitation by man and his grazing animals is apparent from the pollen diagrams from Gujarat, Rajasthan and the U.P. plains (Vishnu-Mittre 1983).

We have so far studied a very small number of charcoal samples and most of the identifications are from single records. They do not therefore allow an estimate of the extent to which the selective exploitation of forests nor the deleterious effects of this practice led to the degradation that we see today. Probably the demographic increase and the manifold utility of wild plant life during the last 7-8 decades have also largely contributed to this.

The present trend among archaeologists to gather ethnobotanical and ethnographic data from extant tribal communities, to interpret archaeological and archaeobotanical data(Nagar 1975, 1985; Murty 1985) is indeed a happy one. There is a growing realization of the value of this aspect of study even among the archaeologists dealing with the Palaeolithic and Mesolithic cultures. A wealth of data can be gleaned from seeds and fruits of wild plant species through the application of the flotation method on bulk samples. These, after accurate identification and environmental analysis can provide information on the past environment of the Palaeolithic and Mesolithic and later cultures. There may occur in archaeological contexts, as often happens, seeds and fruits of wild plants, which are consumed as food or as medicine or made use of in some other manner as conjectured from parallels in modern tribal communities. Without any other convincing evidence that man used them for one or other purpose, we must perforce rely on assumptions and speculations to ascribe a particular use to one or more of the wild plants used by the earlier communities. Great caution needs to be exercised in this area of research. The discovery of seeds of the grape vine (*Vitis vinifera*) has led Indian archaeobotanists to conjecture viticulture having been practised by earlier communities. However, these communities might just as easily have plucked and eaten wild grapes from wild grape vines. *Vitis vinifera* is grown in several varieties today. Did all these forms exist in the past i.e. 1700-1000 B.C. in the Kashmir Valley (Khan 1987). Several of the vines which are cultivated today from Baluchistan to Kashmir are found in India too. There are also certain species which occur wild (Stewart 1972). Have comparisons been extended to all these? The work involved in ascribing a particular use to any single plant species is indeed an enormous task. The fruits and seeds of several wild species of trees for instance are gathered today and were gathered in the past too, for consumption. Does this evidence permit us to state that a particular cultural community had practised horticulture? Until the evidence is available convincingly, we will continue to be governed by assumptions and speculations which occasionally border upon the purely imaginary. We may suggest the practice of sericulture after a discovery of silk (Gulati 1961). Now a charcoal specimen of *Morus alba* has been identified. This is a tree involved in sericulture but caution and restraint must be exercised in such a situation. Till more convincing multiple evidence has become available it would be unwise to postulate sericulture.

Future Tasks and Strategies

There is indeed a great future for archaeobotanical research in the Indian subcontinent. Quite a few problems arising out of the work so far completed have already been discussed. Some of those which need special emphasis and are basic to all archaeobotanical research are highlighted below.

There is an immediate need to shift from the traditional methods of recovery of plant remains to mechanical ones, for instance, the flotation method. The bulk recovery of material from each stratum, from the corners of rooms, from wastage dumps, etc. are likely to yield plant material in enormous quantities some of which will be great surprises also. All the materials so obtained and comprising seeds and fruits and charcoal must be carefully studied employing SEM wherever possible.

To facilitate identification of these bulk plant remains, it is indispensable to build up a Modern Comparative Database (MCD). This should comprise a photograhic catalogue of seeds and fruits and the wood anatomy of all the flora distributed in the region where excavations are being conducted. This task, though gigantic, is invaluable for the proper and authentic identification of plant remains. It will fill a wide gap in our scientific literature. This catalogue should be accompanied by a collection of seeds and fruits and slides of wood sections for actual comparative studies.

The interpretation of the identified plant remains should be based upon the MCD comprising the following:

a detailed environmental analysis of the extant flora,

the nature, composition and distribution of the forest communities as at present and as they were recorded in the first Forest Working Plans,

data on the impact of climatic, biotic and edaphic factors on these forest communities,

biotic data of all aspects of exploitation of major or minor produce of the forest to meet the requirements of the tribals, modern man as well as the animals associated with them,

data on exploitation strategies and technologies adopted by these people,

data on crops cultivated, methods of sowing, cropping patterns, fertilizers used, etc.

The MCD described above should not only confine itself to modern data as it is at present but should include data recorded in the publications of the last two centuries at least. For example, the District Gazetteers, accounts of travellers, books, memoirs, etc., material on anthropology, agriculture and geology, etc. and the earlier publications of the Asiatic Society of Bengal and of several other reputed journals. These provide information on the pre-industrial land-use, irrigation practices, cropping patterns and the use of wild plant life by tribal communities.

This rich source of information can comprise a more than adequate comparative data base and one which is relevant to interpretation of archaeobotanical data, since under the impact of development, introduction of cash crops, creation of man-made forests, large scale destruction of forests to feed industries, laying of roads, creation of new townships, etc., we have shed many ancient practices which were still present two or three hundred years ago. We should therefore, always use this rich source of information of the last few centuries as a base period for comparison (Vishnu-Mittre 1982). There is much in this source of information that surprises us even today. More often than not in utter ignorance we begin to theorise or to reject possibilities like,

.g., was rice grown in the heart of the Sind desert or, was lack cotton soil cultivable or has it ever been cultivated? Much useful information has been extricated from this last eferred to source (Vishnu-Mittre 1974a, 1982; Fentress 1985; Dhavalikar 1985; Sali 1986).

There is yet another rich source of information - our ancient literature in Sanskrit. It is the least tapped one as compared with the literature written in Persian during the Mughal period and earlier. It is admitted that none of these can provide information comparable with what is obtained from archaeological sites prior to the Iron Age because of difficulties and uncertainties in ascribing the oldest of these references to the Neolithic and Copper Bronze Ages. Besides these, are the difficulties of translations of terms relating to plant life as known today. Nevertheless certain startling observations in later literature do indeed compel us to remould our assumptions. To illustrate this, let us take the example of the chick pea (*canaka*, *cana*, *chana*) which we relish today as a pulse or enjoy roasted. Its flour is used in various ways, even in making *khari* and *ladoos*. The Harappans at Kalibangan used it, the OCP people at Atranjikhera used it and there are early historical records of the same from Maharashtra. From its present usage, we might naturally presume chana to have been consumed by the ancient Harappans and the cultures that followed in the same way. Gode (1945, 1946), however, would have us believe that chana was used as food for horses between c. 800 and 1870 A.D. and this is vouched for by five Sanskrit treatises on the ASVASASTRA. Further he gives us to understand that foreign horses were imported into India during ancient and medieval times. This indeed makes us rethink.

Quite a few of the vegetables that we eat today were originally grown as fodder crops. Mutter(*Pisum arvense, P. sativum*) has a similar history. Gawar/Guwar (*Cyamopsis tetragonoloba*) is a more recent adoption of a fodder crop. Food habits have been changing since time immemorial and we have adopted much from the habits of grazing animals.

Extreme caution must therefore be exercised while interpreting data (Vishnu-Mittre 1975; Vishnu-Mittre and Guzder 1975). The re-examination of archaeological materials identified so far on the touchstone of MCD as advocated above will reveal several instances where caution was sacrificed.

In conclusion while reiterating the importance of close collaboration between archaeologists and botanists, I take this opportunity to express my appreciation and immense thanks to you all for unanimously electing me President of the Indian Society for Prehistoric and Quaternary Studies. I am honoured by this. I also wish to record my appreciation of the cooperation I have received from Dr. V.N. Misra, the General Secretary, Dr. G.M. Buth of the Department of Botany, Kashmir University and from Dr. M.D. Kajale of the Deccan College, Pune. My sincere thanks to all of them.

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Stone Age India: An Ecological Perspective

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Introduction

For a variety of reasons our knowledge of human societies of the stone age, especially of their ecological setting, is meagre. First, even though prehistoric research in India began in the early part of the nineteenth century, until about five decades ago it was conducted only by a small number of amateurs. As such the information collected by them was geographically patchy and quantitatively limited. It is only during the post-Independence period that such research has acquired an institutional footing. The number of field workers has steadily grown and so has the volume of archaeological data. Even so the number of active researchers with professional training and motivation is woefully inadequate in relation to the size of the country. Secondly, for prehistoric research to generate useful cultural and environmental data, it has to be interdisciplinary in nature, involving, besides archaeology, geology, ecology, anthropology, palaeontology, and palaeobotany. This is because the temporal dimension we are concerned with encompasses several hundred thousand years, and this period has witnessed drastic changes in landscape, climate, hydrology, flora, fauna and human physical form. Unfortunately, for historical reasons, the pioneering archaeologists were trained in history and their approach was essentially culture-historical rather than anthropological and ecological. Even today the situation has not significantly changed. Only a few archaeologists are aware of the importance of interdisciplinary research and fewer still have the opportunity of working in close collaboration with experts in these related disciplines. The information produced by many archaeologists therefore often remains unbalanced and incomplete.

Because of the length of time involved and the changes in landscape and climate, most of the early (Pleistocene) sites have been either obliterated or disturbed by natural and human agencies. Also, the contemporary biological material which could tell us about subsistence, ecology, technology, structures, etc. has in most cases not been preserved. What has survived is a plenitude of stone tools, often dislocated from their original context, and buried in secondary deposits. Such archaeological material has very limited value for cultural, ecological and chronological reconstruction, though there are some relatively undisturbed surface sites which could be usefully exploited for palaeoecological reconstruction using the present as a key to the past. From the beginning of the Holocene the preservation of both sites and biological material is better. But, in the final analysis, precise information for cultural and ecological reconstruction can come only from excavated primary archaeological sites. The number of such sites is, however, as yet very small. The cultural and ecological reconstruction of early hunter-gatherer societies which follows has therefore to be seen against the background of these limitations.

The Emergence of Man

Palaeoanthropological research during the last three decades overwhelmingly shows that the transition from an anthropoid to the hominid stage took place in Africa. The earliest hominids - Australopithecines and *Homo habilis* - dating from 4 to 2 million years ago were confined to Africa. It was *Homo erectus*, who appeared sometime between 2 and 1.5 million years ago, who colonised the warmer parts of Europe and Asia. Archaeologists have christened the culture of this hominid 'Acheulian' after the type locality of St. Acheul in France. Many fossil finds and a few absolute dates suggest that by at least a million years ago *Homo erectus* was well established in Java and not long afterwards in north China. He could have reached these lands only by traversing the Indian subcontinent. However, neither fossil nor cultural remains of this early date have so far been found anywhere in India. This is probably because the Early Pleistocene geological deposits which could contain such remains have not been preserved in peninsular India, or where they may be preserved as, for example, in the Narmada valley, they are deeply buried, thereby precluding investigation. Recently, British archaeologists have reported late Pliocene age

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artefacts from the Siwalik Hills at Riwat, near Rawalpindi in Pakistan. The artefacts, comprising simple cores and flakes, come from a conglomerate deposit and are associated with naturally fractured pieces. They are dated to two million years on the basis of magnetic polarity stratigraphy (Rendell *et al.* 1987; Dennell *et al.* 1988). The discovery, though highly exciting, stands for the present in a spatial and temporal isolation. It needs corroboration from more finds of artefacts of unequivocal human workmanship and stratigraphical context.

The Earliest Human Occupation: Lower Palaeolithic

The earliest human occupation of India known to us at present belongs to the Lower Palaeolithic stage of prehistory. Two cultures or technological traditions are known from this stage. These are: (1) the Sohanian, represented by pebble tools (choppers and chopping tools), flakes and cores, and (2) the Acheulian, represented by bifaces (handaxes and cleavers), pebble tools, a variety of scrapers, flakes, blades, and cores.

Sohanian Culture

The Sohanian is known only from the Siwalik Hills in northwest India and Pakistan (Fig. 1). Half-a-century ago de Terra and Paterson (1939) reported Early Sohan tools from Terrace 1 (T1) of the Sohan river (a tributary of the Indus river) cut into the Boulder Conglomerate of Second Glacial Age in the Potwar plateau of Pakistan. They also found Acheulian tools on the same deposit, though at discrete localities. They dated T1 to the Second Interglacial age in the four-fold scheme of Pleistocene glaciation that they had proposed for the Himalayas. The faunal remains from this deposit included the horse, buffalo, straight-tusked elephant and hippopotamus, suggesting an environment characterized by perennial water sources, tree vegetation and grass steppes. Younger deposits showed the Sohan industry to have evolved over time. T2, with gravel at the base and loess on top, and dating to the Third Glacial period, yielded Acheulian and Late Sohan A industries from the basal gravels. Late Sohan A comprised refined pebble choppers and Levallois flakes. The overlying loess of the same terrace produced the Late Sohan B industry, characterized by Levallois flakes and blades and by the complete absence of Acheulian elements. The fauna of this horizon included horse, bovids, camel and wolf (Wadia 1928: 287).

Many archaeologists have found it difficult to accept the coexistence of two distinct technological traditions in close proximity without any influence on each other. Recent research in the area by the British Archaeological Mission to Pakistan has shown de Terra and Paterson's geological, climatic and archaeological sequences to be completely untenable. The Sohan terraces turn out to be erosional features rather than true depositional terraces. As the archaeological material found by de Terra and Paterson all came from the surface, it cannot be associated with any specific deposit nor for the same reason can it be dated. The Mission members were unable to corroborate the existence of an independent Sohanian technological tradition though they found artefacts of Acheulian and other traditions (Allchin 1981; Dennell *et al.* 1988). However, geological and archaeological findings on the Indian side appear to conform with de Terra and Paterson's observations in Pakistan. Five terraces similar to those of the Indus-Sohan in the Potwar region have been recognized in the valleys of the Sutlej, Beas, Banganga and other rivers in the Punjab-Himachal Pradesh region. Pebble tools of Sohanian style have been collected on the older of these terraces (Lal 1956; Karir 1985). Mohapatra (1976) who has discovered both Sohanian and Acheulian sites in the Hoshiarpur-Chandigarh sector of the Siwalik hills has argued that the Acheulian and Sohanian populations inhabited two distinct types of environment, the former occupying the flat surfaces of the Siwalik Frontal Range and the latter the *duns* or valleys of the Himalayan flank.

As the archaeological material in the Siwaliks has so far been found almost entirely on the surface, it is not easy to date it accurately. Mohapatra (1976), using several sets of magnetic polarity data from the Upper Siwalik beds of both India and Pakistan, has tried tentatively to date the two sets of Palaeolithic industries. The Sohanian tradition, according to him, appeared in the Mindel-Riss Interglacial (300-400,000 B.P.) and continued evolving up to the end of the Pleistocene. The Acheulian tradition, on the other hand, cannot be older than 200,000 B.P. because it is only around this time that the range became sufficiently stable to support human population.

Occasional claims have been made for the existence of a pre-Acheulian Sohanian tradition in peninsular India (Khatri 1962a; Jayaswal 1982: 57-83; Armand 1983) but they remain to be substantiated by unequivocal stratigraphic evidence.

Acheulian Culture

The first effective colonisation of the country was achieved by the makers of the Acheulian culture. The archaeological remains of this culture, almost entirely in the form of stone tools, have been found extensively from the Siwalik Hills in the north to near Madras in peninsular India (Misra 1987b). The only areas devoid of Acheulian occupation are the Western Ghats and the coastal region running parallel to them (Guzder 1980), northeast India, and the Ganga plains. Claims for Acheulian finds in the Garo Hills in Meghalaya (T.C. Sharma 1974) need to be confirmed by the discovery of such tools in stratified context and without the admixture of later tools. Heavy rainfall and dense vegetation probably inhibited early man from colonising the Western Ghats region and northeast India. Elsewhere in the Old World too early hominids avoided dense tropical forests. In the case of the Ganga valley, the non-availability of stone, the basic raw material for making tools, may have been responsible for man avoiding this region. Alternatively, if Acheulian sites existed here in the past, they may lie buried deep in the alluvium (Fig.1).

Acheulian hunter-gatherer populations were adapted to a wide variety of ecozones. Their cultural remains have been found in semi-arid western Rajasthan (Gaillard *et al.* 1983, 1985; Misra and Rajaguru 1986; Misra *et al.* 1982), the Mewar plain (Misra 1967), Saurashtra (Sankalia 1965a; S. Chakrabarti 1978; Marathe 1981), the Gujarat alluvial plain (Sankalia 1946; Wainwright 1964), in the sub-humid dry as well as the moist deciduous woodland zones of central India (Krishnaswami and Soundara Rajan 1951; Khatri 1958, 1961; Sen and Ghosh 1963; R. Singh 1965; Ahmed 1966; G.R. Sharma 1973a; Jacobson 1970b, 1975, 1976, 1985; Wakankar 1973b, 1975; Misra 1978; Semans 1981; Pant 1982; Kenoyer and Pal 1983; Sharma and Clark 1983; Supekar 1968, 1985; Mishra 1986; Pandey 1987;), the Deccan plateau (Joshi 1955; Sankalia 1952, 1956; Corvinus 1981, 1983; Paddayya 1968, 1982; Pappu 1974; Korisettar 1979; Kale *et al.* 1986), Chota Nagpur plateau (Bose and Sen 1948; Mohapatra 1962; Ghosh 1970;), and the Eastern Ghats and the southeast coast (Soundara Rajan 1952; Isaac 1960; Murty 1966, 1981; S.N. Rao 1968; K.T. Reddy 1968; V.R. Reddy 1968; V.V.M. Rao 1979; Jayaraj 1983; Raju 1983, 1985b).

Acheulian sites are particularly densely concentrated and are richer in central India and the southern Eastern Ghats. Both these regions today receive adequate rainfall, have a thick vegetation cover, and are rich in wild plant and animal food resources (Nagar 1983, 1985; Murty 1985a; Vishnu-Mittre 1985; Schaller 1967). Chemical analysis of sediments from Bhimbetka shelters in central India suggests that conditions in the past were as humid, if not more humid, than they are today. Both plant and animal life must therefore have been abundant. Fossil faunal evidence from the alluvium of the Narmada, Godavari and their tributaries supports this inference. On the northern Deccan plateau sites are comparatively sparse. A plausible explanation for this phenomenon is that basalt which was the only rock used for tool-making in this region is highly susceptible to disintegration by weathering. Thus many or most of the Acheulian sites that did not get buried under the alluvium soon after their use may have been totally destroyed by weathering (Mishra 1982).

Within these broad zones the Acheulian people occupied a variety of microhabitats. In western Rajasthan the discovery of sites buried in fine-grained alluvium around Didwana in Nagaur district suggests that the Acheulian hunter-gatherers camped along lakes and pools in wide flood plains of shallow meandering streams (Fig.2). In addition they also camped on stable dune surfaces and on extensively exposed gravel beds (Misra *et al.* 1982; Misra and Rajaguru 1986) (Figs. 3, 9-10). In the Vindhya Hills region of central India, where natural rock shelters abound, some of them were occupied by Acheulian groups (Joshi 1978; Wakankar 1975; Misra 1978) (Figs. 4-5). At Bhimbetka, one shelter, IIIF-23, revealed a 2.5 m thick Acheulian occupation without any perceptible break (Fig. 6). A few other shelters produced evidence of only short-term occupation. Today there are perennial water springs at Bhimbetka which are the only source of water for human as well as animal populations both domestic and wild. If these springs were also active during the Pleistocene, occupation of the shelters would have been possible throughout the year. However, stone tool industries found in the rock shelters and nearby open-air sites, as at Barkhera near Bhimbetka and Putli Karar area (Jacobson 1985), both in the Raisen district, are so closely similar as to be the work of one and the same people. It would appear that these two locations represent seasonal camping places of the same populations, the rock shelters being used during the rainy season and the open-air sites during the winter months. Over most of the country, however, the hunter-gatherers lived in the open, along perennial as well as seasonal streams (Figs. 7-8). In the latter context the occupation probably took place only during the rainy season and early winter months when water would have been available in the streams and local pools. During the summer months, when water in seasonal streams and pools dried up, all human groups must have been forced to congregate along perennial rivers.

Direct evidence for ecological conditions during the Acheulian period is limited. Because of its low elevation and relative closeness to the Equator the Peninsula was outside the zone of glaciation. However, the regions immediately to the south of the Himalayas did experience the impact of Quaternary climatic changes. Our best evidence of climatic changes and human responses to them during the Quaternary period comes from the semi- arid zone of Rajasthan (Misra 1987a; Misra and Rajaguru 1986). In the drainageless sandy plains of western Rajasthan mighty streams which must have had their origin in the Himalayas existed during the Early Pleistocene. These streams laid down extensive and thick boulder beds in the Nagaur and Jodhpur districts. There is no evidence that man was present in the area during this period. Subsequently the gravel beds were tectonically uplifted and the landscape rejuvenated. The new streams that came into existence were of shallow, anastomising type, flowing in wide flood plains marked with numerous pools and lakes. They deposited marls and calcareous clays in pans or shallow depressions. Acheulian artefacts in mint condition are found buried in these marly deposits as in the Didwana region (Gaillard *et al.* 1983, 1985; Misra and Rajaguru 1986) suggesting that their makers camped along the pools and lakes in the flood plains. They also camped on widely exposed gravel beds where an unlimited supply of fine-grained quartzite for making tools must have been a strong attraction. The climate during this period was essentially semi-arid but it fluctuated several times between cool and dry on the one hand and warm and wet on the other. During cool and dry phases extensive and thick deposition of sand sheets and sand dunes took place, while during wet and humid phases the dunes were stabilized. Acheulian groups occupied stable dune surfaces. While no faunal or plant remains have survived in fluvial and aeolian sediments, the density of Acheulian sites around Didwana strongly implies that plant and animal life must have flourished in abundance.

For peninsular India, some idea of the Acheulian man's environment is provided by the fluvial deposits. Acheulian artefacts here are usually found buried in bouldery and pebbly gravels of the Son, Chambal, Narmada, Godavari and other rivers and their tributaries. These gravels are believed to have been deposited in a semi-arid climate with intermittent, erratic rainfall and sparse to absent plant cover (Williams and Royce 1983). These gravels are invariably covered by fine silts and silty clays which are usually devoid of archaeological material. But this situation is almost certainly due to the fact that such sediments were deposited by low energy streams which were unable to carry coarser material including stone artefacts. Acheulian occupations contemporary with the deposition of fine sediments have to be searched for outside fluvial deposits. Numerous surface Acheulian sites found in central India and the Eastern Ghats are probably such occurrences. Faunal remains have been preserved in Acheulian- bearing gravels in some of the peninsular rivers. The Lower Group of the Narmada stratigraphy which has yielded Acheulian tools contains fossils of *Sus namadicus*, *Bos namadicus*, *Elephas hysudricus*, *Equus namadicus*, *Hexaprotodon namadicus*, *Stegodon insignis-ganesa* which are all believed to be of Middle Pleistocene age (de Terra and Paterson 1939; Badam 1979, 1984). The coarse gravel unit of the Pravara river, a tributary of the Godavari, has yielded fossils of *Bos namadicus*, *Equus namadicus* and *Elephas namadicus* as well as pieces of fossilized tree trunks and branches in association with Acheulian assemblages (Corvinus 1981). These animals indicate the existence of both forest and open grassland environments and the availability of plentiful water round the year. There is little doubt that all these animals formed a source of food for Acheulian populations but whether they were hunted or scavenged or exploited in both these ways can be ascertained only when faunal remains are found in association with undisturbed occupation sites. At the moment such occurrences are conspicuous by their absence.

Acheulian tool assemblages comprise choppers, chopping tools, polyhedrons, spheroids, discoids, handaxes, cleavers, scrapers, denticulates, notches, flakes and blades. Though our knowledge of the functions of most of these tools at this stage is very imperfect, it is certain that they served a variety of functions like hunting, butchering, skinning of animals, shattering and breaking open bones for the extraction of marrow, digging of roots and tubers, processing of plant foods, and making of wooden tools and weapons.

On the basis of stratigraphy, typology and technology two developmental stages can be recognized in Acheulian industries. One, probably chronologically earlier, is characterized by such core tools as handaxes, choppers, polyhedrons, and spheroids, a low proportion of crudely made cleavers and of flake tools, the predominant use of the stone-hammer technique, and the absence of the Levallois technique (Figs. 11-12). It is represented at sites like Singi Talav in Rajasthan (Gaillard *et al.* 1986; Misra and Rajaguru 1986; Misra *et al.* 1982), Chirki-Nevasa in Maharashtra (Corvinus 1983) and Hunsgi (Paddayya 1982) and Anagwadi (Pappu 1974) in Karnataka. The second, and probably younger one, is marked by the low proportion of bifaces, the high ratio of cleavers to handaxes, the very high proportion of flake tools like scrapers, the extensive use of the soft hammer technique, and the knowledge of the Levallois and discoid core techniques. This stage is best represented in the rock shelters of Bhimbetka (Misra 1978) (Figs. 13-14) and the open-air sites in Raisen district of Madhya Pradesh (Jacobson 1975, 1985) and the Tirupati valley in Andhra Pradesh (Murty 1966; Jayaraj 1983).

The raw material used for tool making varied regionally according to the geology of the area and the availability of the rocks. In western Maharashtra dyke basalt or dolerite was the only rock available. Over much of the country quartz and quartzite were used. Wherever fine-grained quartzite was available, it was preferred for its softness and good conchoidal fracture. In the Hunsgi valley in Karnataka the Acheulian people used mainly limestone but occasionally also basalt and granite, and in northern Bundelkhand coarse-grained granite.

Our knowledge of the antiquity and duration of the Lower Palaeolithic culture is far from satisfactory. Reference has already been made to the reported claim of two million year old tools from the Siwalik Hills of the Potwar plateau of Pakistan. The discoverers of these tools have also reported three handaxes from two localities in the same region dated to between 700,000 and 400,000 years on the basis of magnetic polarity stratigraphy (Rendell and Dennell 1985). However more tools and dating by radiometric techniques are needed to confirm the age of the Acheulian industry in the area. In the Indian Siwaliks the Acheulian tradition is thought to be no older than 200,000 B.P. and the Sohanian only slightly older, about 300,000 B.P.

In peninsular India, fauna of the species associated with Acheulian assemblages in the Narmada and Godavari valleys also occurs with the Middle Palaeolithic assemblages, and is therefore of little help for a relative dating of the archaeological material. Dating of Lower Palaeolithic sites and assemblages in absolute years has been hampered by the lack of suitable dating materials such as volcanic ash and tuff. Recently, however, archaeologists from Deccan College, Pune have discovered a thick deposit of volcanic ash underlying a gravel deposit containing an early Acheulian assemblage in the bed of the Kukdi river at Bori, northeast of Pune. The ash has been dated by Potassium-Argon to 1.4 Myr. (Korisettar *et al.* 1989 a & b). The Acheulian ssemblage is younger than 1.4 Myr. but it is difficult to say y how much. Efforts are also being made to date Acheulian tes by Thermoluminescence and U/Th decay series chniques. Application of these techniques to the sites of mrethi in Saurashtra (Marathe 1981) and 16R at Didwana in ajasthan (Misra and Rajaguru 1986; Raghavan *et al.* 1989) uggests that the Acheulian at these sites is older than 00,000 years. There is, however, a strong likelihood that uture research will prove the earliest human occupation of ndia to be considerably older, perhaps going back to the ower Pleistocene, that is between 2.0 and 0.7 million years go. The upper limit of the Acheulian culture is equally ncertain. It can, however, be noted that at many sites the cheulian grades into the Middle Palaeolithic. And, since the vailable absolute dates for the Middle Palaeolithic range rom c. 150,000 to 20,000 B.P., it is quite likely that the cheulian tradition persisted, at least in some areas, well into he Upper Pleistocene. The discovery of handaxes in an pper Palaeolithic context at the 16R locality, near Didwana n Rajasthan, shows that in isolated areas some of the cheulian elements survived well into the later part of the pper Pleistocene.

A cranium of advanced *Homo erectus* has been iscovered in the basal gravels of the Narmada river at Hathnora near Hoshangabad in Madhya Pradesh. From the same deposit Acheulian tools, some of them typologically and technologically similar to those of the Bhimbetka rock shelters, have also been found (Sonakia 1984; Henry de Lumley and Sonakia 1985; M-A de Lumley and Sonakia 1985). Although both the hominid fossil and the tools come from a secondary archaeological context, their association appears quite plausible considering that elsewhere in the Old World too the Acheulian culture is associated with *Homo erectus* fossils.

Middle Palaeolithic

As elsewhere in the Old World, the Acheulian culture slowly developed into the Middle Palaeolithic by shedding some of the older tool types and by incorporating new forms and new techniques of making them. In western Europe, the Near East, north Africa and Central Asia the Middle Palaeolithic occupation sites are associated with the physical remains of *Homo sapiens neanderthalensis* or Neanderthal Man. Though rather robustly built and with prominent supraorbital ridges and residual prognathism of the face, Neanderthal man had attained the brain size of modern man and was of equal intellectual capacity. Though no physical remains of Neanderthal man have been found in India, stone tools very similar to those found with this species in Europe and other areas are widespread in the Subcontinent.

The Middle Palaeolithic culture developed during the Upper Pleistocene, a period of intense cold and glaciation in high altitudes and northern latitudes. Areas bordering glaciated regions experienced strong aridity. That is perhaps the reason why Middle Palaeolithic sites are comparatively sparse in western Rajasthan, the Mewar plateau and the Gujarat plain. In general, however, we may say that the Middle Palaeolithic populations occupied the same regions and habitats as the preceding Acheulian populations (Sankalia 1964) (Fig. 15). Middle Palaeolithic stone tool assemblages have been found in the Sanghao cave near Peshawar (Dani 1964), Sohan valley (de Terra and Paterson 1939; Salim 1986) and near Rawalpindi on the Potwar plateau (Rendell and Dennell 1987), all in Pakistan, Luni valley (Misra 1961), around Didwana (Misra 1987a; Misra and Rajaguru 1986), and around Budha Pushkar (Allchin *et al.* 1974, 1978), in western Rajasthan, at numerous sites in the valleys of the Chambal, Son and Narmada and their tributaries in central India (Allchin 1959; Khatri 1958, 1962b; Ahmed 1966; Pant 1982; Sharma and Clark 1983; Misra 1985a; Pandey 1987), on the Chota Nagpur plateau (Mohapatra 1962; Ghosh 1970), on the Deccan plateau (Sankalia 1956; Malik 1959; Paddayya 1968, 1974; Pappu 1974), and in the Eastern Ghats (Isaac 1960; Murty 1966; S.N. Rao 1966; K.T. Reddy 1968; V.R. Reddy 1968; V.V.M. Rao 1979; Nanda 1984).

As happened during the Acheulian period, Middle Palaeolithic occupations occurred at open-air sites along perennial as well as seasonal streams, along hill slopes and on stable dune surfaces as in western Rajasthan (Allchin *et al.* 1978; Misra and Rajaguru 1986), and in rock shelters as in central India (Joshi 1978; Misra 1985a). Evidence from the site of Samnapur in Narsinghpur district, M.P. shows that in this case Middle Palaeolithic groups camped on high alluvial flats away from the river channel and close to the hills. This location provided protection from the floods and easy access to good quality chert in the Vindhyan Hills (Figs. 16-17).

Significant changes took place in technology during this period. The use of bifaces (handaxes and cleavers) as also of heavy core tools like choppers, polyhedrons and spheroids slowly disappeared. Instead, tools made on flakes and blades (parallel-sided thin flakes) became more common. Side scrapers of various types, end scrapers, denticulates, notches, points and borers are the most common tool types of this period (Figs. 18-20). These were made by the application of retouch, that is, by finely trimming the edges of parent flakes by the removal of tiny thin flakes or chips. Many of the scraper forms are believed to have been used for manufacturing wooden tools and weapons and also for processing animal hides. Some of the points are thought to have been hafted in wooden shafts for use as spears. Tools became smaller, thinner and lighter. Improved and economical techniques of removing flakes from cores such as the Levallois and discoid core techniques were used extensively. There was also a significant change in the choice of rocks for making tools. While quartz, quartzite and basalt continued to be used, in many areas they were supplanted in varying degrees by chert and jasper and other fine-grained siliceous rocks. Raw material for making tools was sometimes brought from considerable distances. At Samnapur, for example, while the chert used for making the bulk of the tools was available on the hill close to the site, other rocks like quartzite and basalt were brought as cobbles from hill slopes and seasonal stream beds several kilometres away. Factory sites with vast quantities of artefacts in various stages of manufacture occur on chert outcrops as at Choli Dongargaon near Maheshwar on the Narmada and at Sojat in Pali district of Rajasthan. It is obvious that human groups regularly visited these places to exploit the abundant raw material, taking the finished tools to their camping places and leaving the debitage behind. The smaller size of the tools is probably due to the choice of the raw material. Chert and jasper are usually only available in the form of small nodules and therefore impose a natural restriction on the size of the tools.

Our knowledge of the environment of this period is as limited as that of the preceding Middle Pleistocene. In the northern part of western Rajasthan the discovery of Middle Palaeolithic assemblages in fine-grained deposits shows that the drainage system continued to function though perhaps in a considerably weakened condition. The presence of several phases of dune accumulation and stabilization in the 16R profile at Didwana is indicative of multiple fluctuations in rainfall. The faunal remains from the Upper Group of the Narmada alluvium comprising *Equus namadicus*, *Bos namadicus*, *Hexaprotodon palaeindicus*, *Elephas hysudricus*, *Stegodon insignis-ganesa* and *Cervus* sp. are largely similar to those from the Lower Group of Middle Pleistocene age. They suggest a savanna grassland environment interspersed with swamps and forests (de Terra and Paterson 1939; Badam 1979, 1984). Plant fossils have been found in association with Middle Palaeolithic tools in a tufaceous deposit at Wajjal in the Hunsgi valley in Karnataka (Korisettar *et al.* 1977).

Several Thermoluminescence and Uranium/Thorium decay series dates available from the 16R dune profile in western Rajasthan range between 150,000 and 100,000 B.P. Nearly twenty radiocarbon dates obtained mostly on shell and bone are available from the Deccan and central India. These range in age from 40,000 B.P. to 10,000 B.P. In the absence of adequate reports on associated archaeological material one cannot always be sure of the Middle Palaeolithic identification of the stone industries. Also both shell and bone are susceptible to secondary contamination from the residual radioactivity. Keeping these limitations in mind it is clear that Middle Palaeolithic assemblages persisted over a long time span covering the terminal Middle Pleistocene and greater part of the Upper Pleistocene.

Upper Palaeolithic

The tendency to use parallel-sided flakes or blades for making tools and the reduction of size of the tools was further accentuated during the terminal Upper Pleistocene. Also regional variation in technology began to be more clearly manifested during this period. The cultures of the terminal Pleistocene are grouped under the broad category of Upper Palaeolithic. In Western Europe and the Near East where such cultures were first found they are invariably associated with the physical remains of modern man, that is, *Homo sapiens sapiens*. In India although so far skeletal remains of modern man of this stage have not been found, there is widespread evidence of his cultural remains.

Environment During the Terminal Pleistocene

As a result of considerable multidisciplinary palaeoclimatic research in various parts of India during the last 10-15 years we have a much better picture of the environment during the terminal Pleistocene. This period witnessed intense glaciation in high latitudes and extreme aridity in most of peninsular India. In western Rajasthan, north of the Luni river, the Himalayan drainage which had been steadily declining in importance and shifting westward from the Early Pleistocene onwards now fell into disuse over the greater part of the desert. However, the presence of several wide palaeochannels with Upper Palaeolithic sites along their banks between Jaisalmer and Ramgarh shows that, in the extreme northwest corner of the State, rivers continued to flow even during the terminal Pleistocene and probably during the early Holocene as well (Figs. 22-23). Nearly everywhere aeolian activity was intense, leading to deposition of extensive sand sheets and sand dunes in Rajasthan, Punjab, Haryana and Gujarat (Wasson *et al.* 1983; Misra and Rajaguru 1986). Several Thermoluminescence dates obtained on sand quartz from Rajasthan and Gujarat have helped in accurately dating this phase of aridity (Singhvi *et al.* 1982). Geomorphic evidence also suggests that the aridity extended even to the humid regions of northeast India and the southeast coast. Quaternary sediments including fluvial and colluvial deposits of upland Maharashtra and Manipur, aeolianites and calcarenites of Saurashtra, Kutch and Tamil Nadu, and oolitic limestones of the continental shelf of the Arabian Sea have been dated by Carbon 14 and U/Th decay series methods (Fontugne and Duplessy 1986; Rajaguru 1983; Kale and Rajaguru 1985, 1987; Baskaran *et al.* 1986). Well-dated geomorphic data suggest that the vegetation cover over most of the country thinned out during the terminal Pleistocene. As a result of the decreased rainfall and the reduction in vegetation cover on the valley slopes, considerable colluvial sediments were contributed to upland rivers like the Krishna, Bhima and Godavari in Maharashtra and to the Imphal river in Manipur. Owing to decreased discharge and increased sediment loads, most of the streams in these regions aggraded and developed an anastomising drainage pattern at this time (Rajaguru 1983; Rajaguru and Korisettar 1987; Thokchom 1987).

At around 20,000 B.P., the Lokthak lake in the Manipur valley shrank and thick colluvial cones developed in its periphery due to increased frost activity, and reduction n rainfall and possibly also in vegetation density. In coastal reas in the interior parts of southwestern Tamil Nadu, aurashtra and Kutch quartz and carbonate dunes developed s a result of lowered sea level also occurring at approximately 20,000 B.P. Extensive formation of an oolitic arbonate reef on the continental shelf of western India round 12-10,000 B.P. suggests reduction in discharge in the esterly-flowing streams of Maharashtra and Karnataka. n sum, during the terminal Pleistocene southwesterly onsoons were weak and the sea level was lower by scores f metres. Thus the palaeoclimatic evidence suggests that he Indian subcontinent was a part of the global circulation attern during the peak of the Last Glaciation, that is, around 0,000 B.P.

The rich fossil record from the deposits of the peninsular ivers of this period provides us a good picture of the fauna. inds from the Belan valley, a sub-tributary of the Ganga, outh of Allahabad, the Mahanadi and Manjra valleys in entral India, and the Godavari, Ghod and Krishna valleys in he Deccan include *Canis* sp., *Bubalus* sp., *Cervus* sp., *Bos amadicus*, and *Hexaprotodon palaeindicus*. The fauna uggests the existence of a grassland environment with ockets of forests and swamps. The discovery of ostrich egg hells at over forty sites in Rajasthan, Madhya Pradesh and aharashtra, several of them dated by C14, shows that the strich, a bird adapted to arid climate, was widely distributed n western India during the later part of the Upper Pleistocene (Kumar *et al.* 1988).

Human Adaptations During the Terminal Pleistocene

Because of the arid climate and consequently sparse egetation and animal life at this time the human populations were faced with much restricted food resources. These ircumstances must certainly have led to a reduction in uman population. This is suggested by the sparse human ettlements found during this period. In Pakistan (Allchin 976) and western India (Rajasthan and Gujarat) only isolated ites of this phase have been found. People here camped on and dunes as at Budha Pushkar (Allchin *et al.* 1974) and Didwana (Misra and Rajaguru 1986) in Rajasthan. In central ndia too only a limited number of sites are known from the on valley (Kenoyer *et al.* 1983) and Bhimbetka rock shelters Misra 1985a). It is only in the relatively humid region of the astern Ghats that the Upper Palaeolithic sites are plentiful, uggesting a concentration of population in this area (Murty 968, 1974, 1979, 1981, 1985b; Murty and Reddy 1976; K.T. Reddy 1970; Raju 1983, 1985a, 1987, 1988) (Fig. 21).

The Indian Upper Palaeolithic tool assemblages are ssentially characterized by blade tools and show a marked egional diversity in respect of refinement of techniques and tandardization and numerical proportion of finished tool orms. Wherever these assemblages occur in a stratified ontext, they succeed the Middle Palaeolithic and precede the Mesolithic. The principal artefact forms in these assemblages are scrapers (side, convex, notch, end, steep, round, convergent, etc.) made on flakes, flake-blades, blades and cores; backed blade variants (straight back, curved back, backed knives, points with backing confined to either base or tip or both, lunates, triangles and trapezes); burins made on flake-blades, blades and split cores; unifacial, bifacial and tanged points on flakes, blades and nuclei; choppers, and worked nuclei. Scrapers made on flakes which are common to all regions suggest continuity of the Middle Palaeolithic tradition (Figs. 27-28). Broad and thick blades (flake-blades) struck from crude prismatic cores are the important feature of sites in the Subarnarekha valley of Bihar (Ghosh 1970) and Garo Hills in Meghalaya (T.C. Sharma 1985). Parallel-sided blades struck from standardized prismatic cores are common on sites in the Thar desert (Allchin *et al.* 1974, 1978; Misra and Rajaguru 1986), Belan and Son valleys (Sharma and Clark 1983), Damin (Dhamni) area of Rajmahal Hills (D.K. Chakrabarti 1985), Bhimbetka shelters (Misra 1985a), Maharashtra plateau (Sali 1985, 1989), Telangana plateau (T.R.R. Singh 1984), Mysore plateau (Paddayya 1970) and Eastern Ghats (Murty 1970; K.T. Reddy 1970; V.V.M. Rao 1979; Raju 1988). Though a few backed blades, retouched blade tools and burins occur at most of the sites, assemblages in some regions reveal distinctive features. Simple blades and retouched blade tools are conspicuous at sites in the Deccan plateau (Paddayya 1970). At sites in the hinterland riverine ecosystems of the Eastern Ghats the backed blade component is much higher among the finished tools (Murty 1970; Raju 1988). The Epi-Palaeolithic and Late Palaeolithic of the Son and Belan valleys comprise a low proportion of short blade element and a predominant flake element (Sharma and Clark 1983). In sum, the terminal Pleistocene lithic assemblages in most of the regions in India exhibit a predominant component of amorphous elements which shows a striking resemblance to assemblages in Southeast Asia. The bone tool element is so far available only from the Kurnool caves, and it represents a crude facies (Murty 1974).

These lithic assemblages occur in occupation scatters dispersed in desert grassland, woodland, woodland savanna, scrub woodland and thorny thicket zones (Figs. 24-26). Several species of game inhabit these regions, the most important of them being nilgai (*Boselaphus tragocamelus*), chinkara (*Gazella gazella*), four-horned antelope (*Tetracerus quadricornis*), sambar (*Cervus unicolor*), chital (*Axis axis*), barking deer (*Muntiacus muntjac*), mouse deer (*Tragulus* cf. *meminna*), wild boar (*Sus scrofa cristatus*), jungle cat (*Felis chaus*), porcupine (*Hystrix indica*), hare (*Lepus nigricollis*), giant squirrel (*Ratufa indica*), monitor lizard (*Varanus dracaena*), and langur (*Presbytis entellus*). While remains of most of these species occur in late Pleistocene riverine deposits, and are also closely associated with Upper Palaeolithic occupations in Kurnool caves (Murty 1975), there is fossil evidence showing the distribution of other species like ox (*Bos* sp.), buffalo (*Bubalus* sp.), horse (*Equus* sp.), hippopotamus (*Hippopotamus* sp.), rhinoceros (*Rhinoceros* sp.), and elephant (*Elephas* sp.) (Badam 1979; Sharma and Clark 1983). Besides, these ecosystems are also rich in avifauna and a wide variety of plant foods like yams, fruits, flowers, nuts, bamboo shoots, bamboo grain, leafy vegetables and mushrooms (Murty 1985a; Nagar 1983, 1985; Vishnu-Mittre 1985).

Varied ecological niches in these ecosystems are exploited today by traditional ethnic groups (tribes/Adivasis) whose economies are geared to hunting and gathering, riverine fishing, marine fishing, and shifting cultivation. Typical examples are those known as Van Vagri (Thar desert), Birhor (Chota Nagpur), Chenchu, Yanadi, Konda Reddi, Koya, Voda Balije (Eastern Ghats), Kadars (Kerala), Baiga or Bhumiya, Gond, Abujhmaria, Muria, Bison-horn Maria Gond (Madhya Pradesh), Kandh, Savara, Gadaba, Juang (Orissa), and Warli and Koli (Maharashtra). All these ethnic groups, notwithstanding the fact that they are now integrated into the village economies, pursue their traditional modes of food procurement. Since big game is now both scarce and its hunting is prohibited, they hunt small game and birds, and collect insects and honey and wild plant foods. For hunting game and birds they use nets, spring traps, gravity traps, noose traps, snares, pit falls, and different kinds of bow and arrow. They possess an intimate knowledge of their biological environment and are skillful trackers. All these kinds of hunting and fishing aids involve considerable wood work, bamboo work, and cord work. The fact that stone age occupations occur within the tribal habitats indicates that the game and other forest foods now exploited must have formed the subsistence base for the terminal Pleistocene populations, possibly on a much larger scale.

If the food procurement technologies and behaviour as reflected in the ethnographic present are any guide, then it is to be expected that prototypes of traps, snares, nets, etc. must have been in use during the terminal Pleistocene times and later. If that was the case, the scraper variants and other amorphous forms were possibly used for wood and bamboo work. The simple blades and some of the backed blade variants could have been used as inserts for spear points, arrow points, fishing arrows, barbed fishhooks, thrusting spears, slicer knives and daggers. Some of the broad and thick flake-blades and large pointed blades could have been fixed into a resin handgrip or into wooden handles, recalling the Australian Leilira knives. The gum of several species of *Acacia*, lacquer from the nests of tree ants, and the milky juice of *Excoecaria agallocha* (which hardens on exposure to air into a black catechu-like substance) which are used today by traditional ethnic groups, might have been used for hafting purposes. Some of the blades and backed point variants could have been used as pen knives for cutting off the surplus cord work and knot tips in the binding and interlacing of various strands of thin cord into a network for making fishing and hunting nets.

In the hinterland riverine ecosystems of the Eastern Ghats lithic assemblages with a predominant backed blade and burin element also have another important tool, a large crescentic backed piece with blunted arc and straight cord, recalling the Australian Elouera (Fig. 27). Most of these tools have damaged cords, indicating that they were certainly used for wood work. Another striking feature of sites in this region is the presence of a considerable number of bored stones and grinding slabs. Similar bored stones today are used by the Yanadi as net sinkers in riverine fishing, and the heavier ones are used by Voda Balije and other contemporary groups for marine fishing. Further, these occupations in the Eastern Ghats are invariably associated with permanent water bodies, which are exploited today by the Yanadi, lending support to the inference that aquatic foods (fish, prawn, crabs, tortoise, resident and migratory water birds) must have been a valuable food resource during terminal Pleistocene times as they are today. The grinding stones found with these assemblages are likely to have been used in the processing of plant foods including wild rice (*Oryza nivara*) which is widespread in the Eastern Ghats. The small microlithic backed blade element of the Upper Palaeolithic assemblages is suggestive of its use in sickles for harvesting (Misra and Murty 1986).

Continuity from the Upper Palaeolithic to the present may not be confined to the technological and economic spheres alone. At the site of Baghor II in the Son valley archaeologists found a rectangular stone rubble platform with a triangular stone with natural concentric circles installed in its centre. Similar stones installed on stone platforms are today worshipped as mother goddesses by tribal communities in the area. The Baghor structure therefore probably represents the earliest shrine in India and suggests a remarkably long continuity of mother goddess worship (Kenoyer *et al.* 1983).

The Upper Palaeolithic occupations of the Eastern Ghats are far more extensive than those in the rest of the country. Some of the sites in the area such as, for example, Vodikalu in the Gunjana valley in the Cuddapah district (Raju 1988) extend over five acres and the artefacts run into several thousands. Two radiocarbon dates from this region are 17,390 B.P. and 24,360± 660/710 B.P. Radiocarbon and TL dates from other parts of the country range between 30,000 and 10,000 B.P. A blade tool assemblage from the Potwar plateau of Pakistan has been dated by TL to c. 40-45,000 years B.P. (Rendell and Dennell 1987).

Mesolithic

The hunting-gathering cultures of the early and middle Holocene are collectively assigned to the Mesolithic period. Whenever found in a stratified context they succeed the Upper Palaeolithic and precede the Neolithic and Chalcolithic. For a number of reasons our knowledge of the

Mesolithic cultures and their ecological setting is much better than that of the earlier cultures. First, there have been no significant natural changes in the landforms since their occupation by Mesolithic communities. Therefore the sites of this period are preserved in larger numbers and are in better condition. Secondly, the preservation of organic matter, specially animal remains, at these sites is much better. These remains provide us with useful information about subsistence, environment, technology, and ornaments. Thirdly, a number of habitation sites of this period have been excavated and they have provided rich data for Mesolithic lifeways and environment. Fourthly, for the first time human burials make their appearance in the archaeological record, adding substantially to our knowledge about mode of the disposal of the dead. And finally, the rich rock art of this period throws a valuable light on the aesthetic content as well as on many other aspects of the cultures of Mesolithic societies.

The number and density of sites of the Mesolithic period is far greater than those of all the phases of the preceding Palaeolithic period (Fig. 29). The Mesolithic people inhabited more intensively the previously colonised habitats, like the arid and semi-arid sandy plains of western Rajasthan (Misra 1973b; Allchin *et al.* 1974, 1978) and north Gujarat (Subbarao 1952; Sankalia 1965b; Malik 1966; Allchin and Goudie 1971; Allchin *et al.* 1978), the rocky plateau of Mewar (Misra 1967), the hilly and forested country of central India (Brown 1889; Gordon 1950; Jacobson 1970a, 1976; Wakankar 1973b, 1975; Misra 1976; Sussman *et al.* 1983; Cooper 1983; Pal 1986; Varma 1986), the hilly tracts of Orissa (Mohapatra 1962; Nanda 1984; Mohanty 1988), the Chota Nagpur plateau (Ray 1975, 1985), the semi-arid and rocky Deccan plateau (Joshi and Bopardikar 1972; Sankalia 1974; Sali 1989), the Bombay coast (Todd 1950; Gordon 1950), Telangana plateau (Murty 1970; T.R.R. Singh 1984), and Eastern Ghats (Isaac 1960, Murty 1966; S.N. Rao 1968; K.T. Reddy 1968; V.R. Reddy 1968; V.V.M. Rao 1979). Elsewhere they extended their colonisation into virgin territories like the Ganga valley (G.R. Sharma 1973b; Sharma *et al.* 1980), Damodar valley (Lal 1958), the hilly tracts of Gujarat (Sonawane 1983), the Kerala coast (Rajendran 1983, 1984), and the southern Tamil Nadu coast (Zeuner and Allchin 1956). The effective human colonisation of the forest-covered alluvial plains of the Ganga valley was achieved by the Mesolithic pioneers. Nearly 200 sites of this period have been located in the south central part of the valley in Allahabad, Pratapgarh, Jaunpur, Mirzapur and Varanasi districts (Sharma *et al.* 1980).

Mesolithic communities exploited a greater variety of habitats than their predecessors. In the Gujarat plains they settled on sand dunes on the shores of interdunal lakes (Fig. 30) and in the Mewar plain on elevated rocky ground as well as on river bank dunes (Figs. 31-32). In the woodland zones of the Vindhyas and the Kaimur Range they occupied caves and rock shelters as well as open-air locations. The limestone caves in the Kurnool district of Andhra Pradesh were also occupied during this period. In the wooded ecosystems of the interior Peninsula there are numerous sites right in the habitat of the shifting cultivators of the present day. Along the west coast, near Bombay, the Mesolithic groups settled on the tops of hills and rock outcrops near the sea coast. Near the tip of the Peninsula, on the east coast, there are occupations on coastal sand dunes (*Teris*). These coastal occupations are suggestive of marine food exploitation. Likewise, the occupations on the shores of ox-bow lakes in the Ganga valley (e.g. Sarai Nahar Rai, Mahadaha and Damdama), those close to water falls in the Telangana plateau (e.g. Gauri Gundam and Pochara), around Chitrakot Falls in Bastar, and in the riverine niches of the Eastern Ghats indicate considerable dependence on aquatic food resources.

A dramatic increase in the number of occupation sites during the Mesolithic period in different parts of India is a positive indication of significant demographic increase during early Holocene times. Palynological and sedimentological studies of the salt lakes (Singh *et al.* 1974; Wasson *et al.* 1984) and of the weathering profiles of the sand dunes (Misra and Rajaguru 1986; Raghavan 1987) in Rajasthan, and sedimentological studies in the Belan and Son valleys (Sharma and Clark 1983) have shown that there was a marked increase in rainfall at the beginning of the Holocene. If such an increase in rainfall was experienced by other regions of the country also, then several habitats could have afforded a wide spectrum of subsistence sources and attracted microlithic tool-using populations. The advent of microlithic technology, the manufacture of composite tools (depicted in central Indian Mesolithic rock paintings), and widespread appearance of grinding stones must have led to specialized methods of food procurement and processing and thereby to more successful adaptations (Allchin 1966).

The lithic traditions are characterized by a highly developed blade and bladelet tool technology. The overall tool types of this period which are of microlithic composition are parallel-sided blades and bladelets, backed blade variants, pen knives, lunates, obliquely blunted blades, triangles (scalene, isosceles and equilateral), trapezes, unifacial, bifacial and tanged points, side scrapers, end scrapers, burins, and occasional small choppers (Figs. 33-34). There is also the evidence for the use of bone and antler tools. The Mesolithic deposits at Bhimbetka yielded bone points, pendants and pieces of antler with sharp cut marks (Fig. 35). The site of Mahadaha in the Ganga valley has produced arrowheads, points, knives, chisels, scrapers and saws of bone and antler. Besides, a number of rings cut from antler have been found at this site, some of them found worn as ear rings and necklaces in burials. At the sites of Lekhahia and Baghai Khor in the Kaimur hills of Mirzapur region in Uttar Pradesh, a sequence of four phases in the occurrence of microlithic industries has been identified. These are: Phase I, pre-pottery non-geometric microliths; Phase II, pre-pottery geometric microliths; Phase III, pottery and geometric microliths (triangles and trapezes); and Phase IV, pottery and diminutive geometric microliths. The raw materials used for making microliths and other tools vary from milky quartz, crystal, fine-grained quartzite to crypto-crystalline silica, the first three being predominantly used at the eastern and western littoral sites.

The excavated sites of Tilwara (Misra 1971), Bagor (Misra 1971, 1973a), Bhimbetka (Misra 1985a), Adamgarh (Joshi 1978), Langhnaj (Zeuner 1963; Karve-Corvinus and Kennedy 1964; Sankalia 1965b; Clutton-Brock 1965), Sarai Nahar Rai (G.R. Sharma 1973b), Mahadaha (Sharma *et al.* 1980), Damdama (Varma *et al.* 1985) and Muchatla Chintamanu Gavi (Murty 1974, 1981) have yielded large quantities of animal bones representing food refuse. The bones most common in the food refuse belong to Indian humped cattle, gaur, buffalo, sambar, chital, nilgai, chinkara, hog deer, fox and jackal. In addition, rhinoceros and barasingha were hunted at Langhnaj, elephant at Sarai Nahar Rai, and porcupine at Adamgarh and in the Kurnool caves. At Bagor, Sarai Nahar Rai, and Kurnool caves there are bones of *Chelonia* sp. and at Bagor and Langhnaj there are remains of fish. Charred bones found at most of the excavated sites indicate that meat was roasted or barbecued for consumption.

Mesolithic peoples were the first to practise systematic disposal of their dead. Human burials have been found from the sites of Langhnaj (Sankalia 1965b; Ehrhardt and Kennedy 1965), Bagor (Lukacs *et al.* 1982), Lekhahia and Baghai Khor (Varma 1986), Bhimbetka (Misra *et al.* 1977), Sarai Nahar Rai (G.R. Sharma 1973b; Kennedy *et al.* 1985), Mahadaha (Sharma et *et al.* 1980), and Damdama (Varma *et al.* 1985). The dead were interred in graves in extended or crouched position, and a variety of offerings like chunks of meat, stone and bone tools, and pieces of haematite were placed with them.

Many thousands of paintings in caves and rock shelters in the Vindhya and Kaimur Hills provide a vivid view of the lifeways of the Mesolithic peoples (Wakankar 1973a; Wakankar and Brooks 1976; Misra *et al.* 1977; Neumayer 1983; Mathpal 1984). The hunting scenes at Bhimbetka and other caves and rock shelters show the hunt of a variety of game with spears, bows and arrows, all tipped and barbed with microliths, hunters chasing (in one scene there are 80 individuals in the expedition) and cornering the game; shooting arrows at the prey; transporting the kill (to the home base); butchering; fishing by using net traps (26 varieties of fish have been recorded in the rock paintings); and trapping of small game, birds, rats and turtles (Figs. 36-37). Women are shown participating in cornering the game. Other food gathering activities shown in the paintings are collection of fruits, women carrying baskets full of fruits; honey collection; and using rubbers and querns.

Apart from hunting, gathering and fishing, there is evidence at some sites indicating the antecedent stages leading to food production. At Bagor, an extensive Mesolithic habitation site on a sand dune, there is evidence of domestic sheep, goat and cattle (in addition to the wild game) from Phase I (c. 5,000-3,000 B.C. on radiocarbon dates), suggesting a certain degree of dependence on animal herding. Remains of domestic cattle, sheep and goat are also found at Adamgarh; and domestic sheep and goat are also present in the late Mesolithic levels in Kurnool caves. Grinding stones and bored stones occur in varying frequency at most of the sites. Sites in the Mewar region, the Vindhyas and the Ganga valley have yielded, right from the early Mesolithic phase onwards, mullers, querns and rubbers (Fig. 38). The presence of carbonised grains of wild rice in the lumps of burnt clay in association with mullers and querns in the advanced Mesolithic (or Proto- Neolithic) at Chopani Mando is indicative of harvesting and processing of wild grain foods (Sharma *et al.* 1980). At Koldihwa, a Neolithic site 3 km east of Chopani Mando, are found imprints of domestic rice on pottery. This Neolithic occupation has three radiocarbon dates: 6,570 ± 210 B.C., 5,440 ± 240 B.C. and 4,530 ± 185 B.C. Another important feature of the advanced Mesolithic at Chopani Mando is the occurrence of remains of wild sheep, goat and cattle. At Mahagara, yet another nearby Neolithic site, the remains of these animals belong to the domestic species. The advanced Mesolithic sites of the Vindhya Hills and the Ganga valley are also associated with crude handmade pottery of red ware and burnished grey ware, beehive type settlements of circular huts, hearths, and burials. The evidence of stone-paved structures has also been recorded at Bagor.

An interesting feature of the Indian Mesolithic is its survival well into the Neolithic-Chalcolithic and indeed even into early Iron age times. What is more, the Mesolithic groups are drawn into the ambit of village economics and exchange systems. At Langhnaj, in the middle levels of the occupation, was found a copper knife, the source of which could be one of the neighbouring Harappan sites. At Bagor, Phase II (c. 2,800-600 B.C.), copper arrowheads, an awl, hand-made pottery and numerous stone and bone beads are found which must have been obtained from the Harappan and Chalcolithic communities of north Rajasthan and Mewar. At Bhimbetka, Langhnaj and Lekhahia, iron arrowheads and wheel-made pottery have been found in the topmost level. The Mesolithic groups must have obtained these items by exchange (for a variety of forest produce, meat of wild game, etc.) from settled farming communities, as is the case in the ethnographic present. With the emergence of village-based economies in the Mesolithic habitats, the hunting-gathering populations came in gradual and closer interaction with the former, and possibly would have become marginal enclaves which is the case with the surviving traditional ethnic groups of India today.

This broad survey of hunting-gathering societies over a period of half-a-million years or so reveals a steady improvement in technology, knowledge of the resources of the environment, sedentariness and expansion of settlement.

There were several significant changes in environment (specially temperature, rainfall and hydrology) during Middle and Upper Pleistocene and early Holocene times which in turn must have affected the flora and fauna. The periodic expansion and contraction in water sources and in plant and animal food resources affected population growth and migration. By mid-Holocene times the ecological knowledge-base of at least a few communities had reached the stage where they could make the revolutionary transition from age-old subsistence mode of hunting-gathering-fishing to animal husbandry and plant agriculture.

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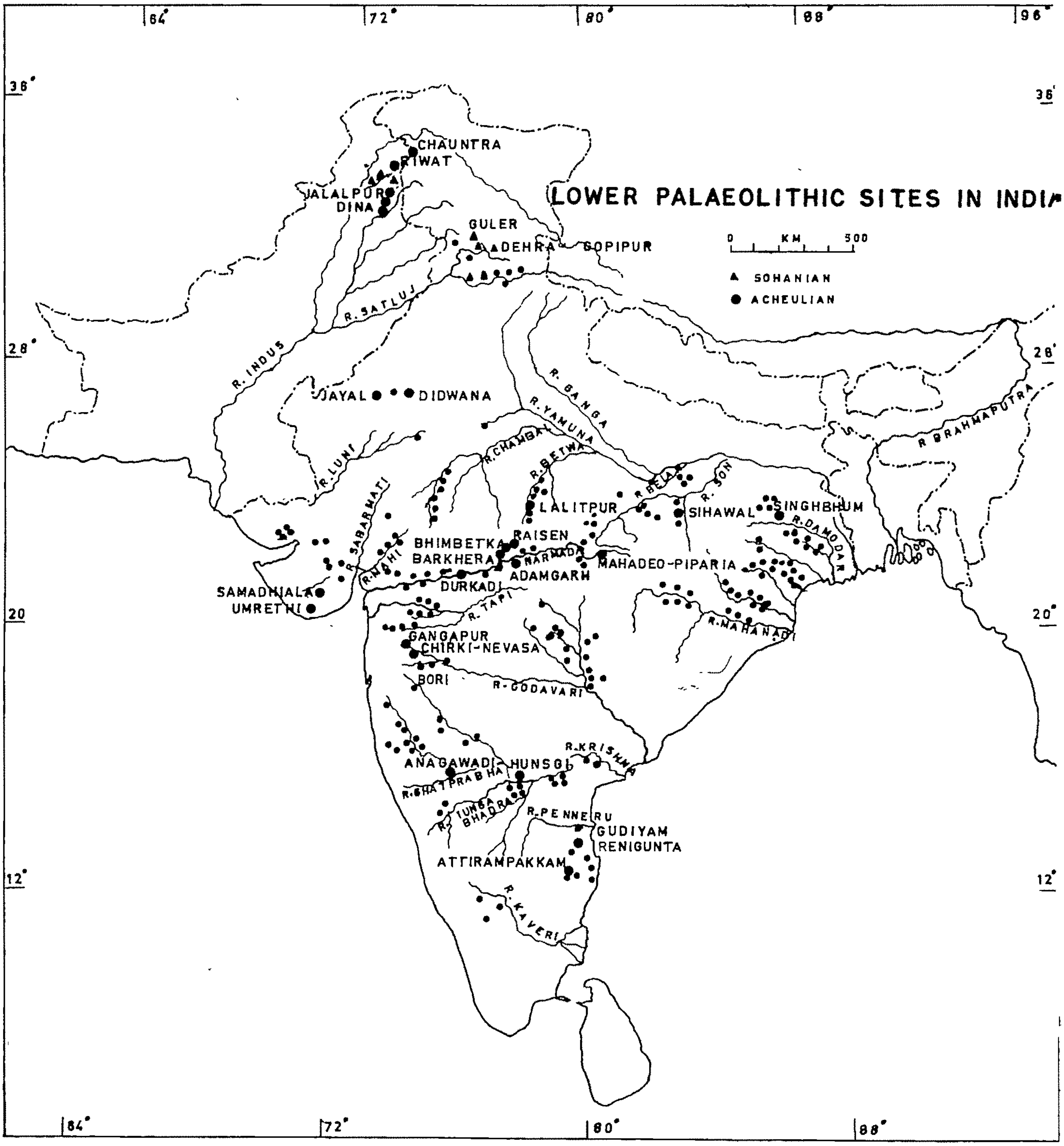

Fig. 1: Lower Palaeolithic

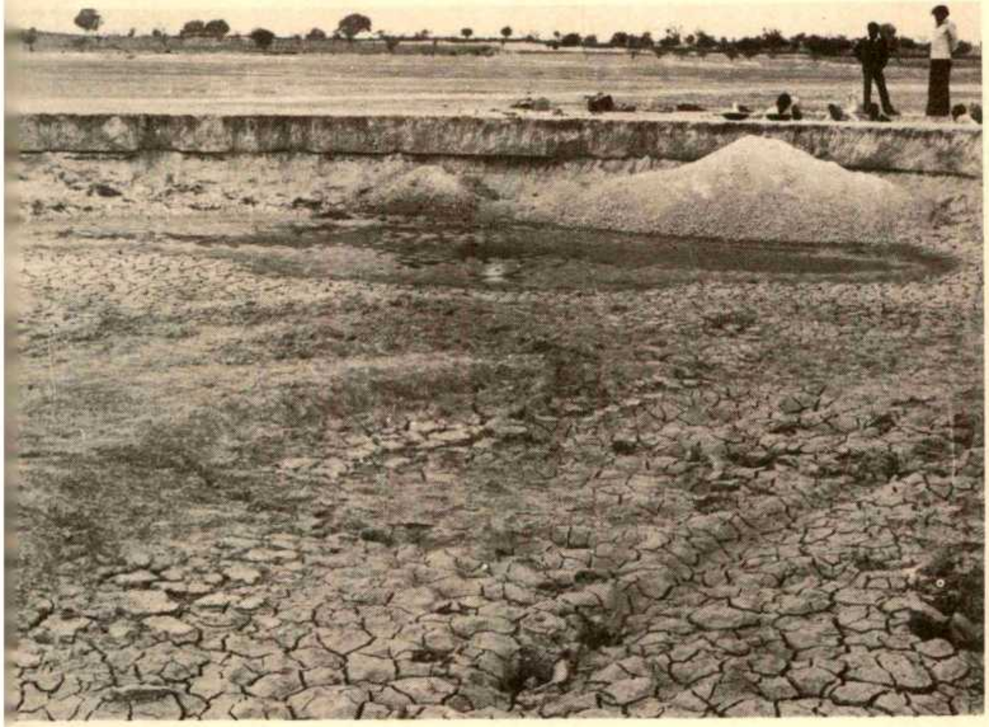

Fig. 2: Early Acheulian site at Singi Talav, near Didwana, Rajasthan. Artefacts in a remarkably fresh condition occur in clusters in the silty clay deposit which was formed in sluggishly flowing streams or in lakes and pools. Hunting-gathering groups camped along such water bodies

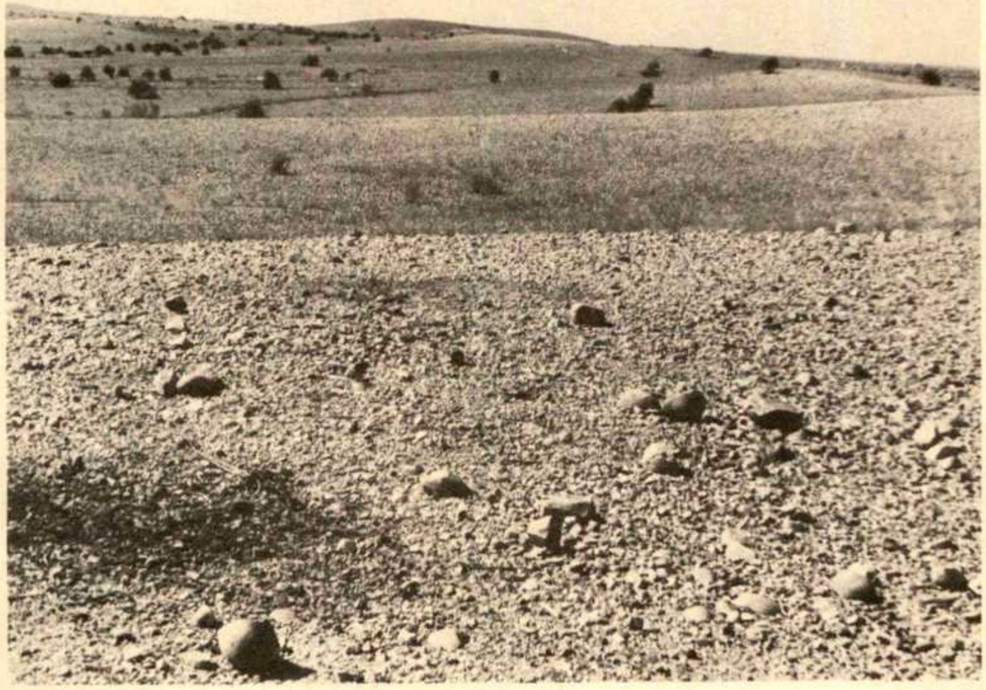

Fig. 3: Jayal Gravel Ridge, district Nagaur, Rajasthan. Extensive scatters of artefacts from Lower Palaeolithic to Mesolithic occur on the surface of the ridge. Stone age groups were attracted to the ridge by the abundant supply of fine-grained quartzite and quartz for making their tools

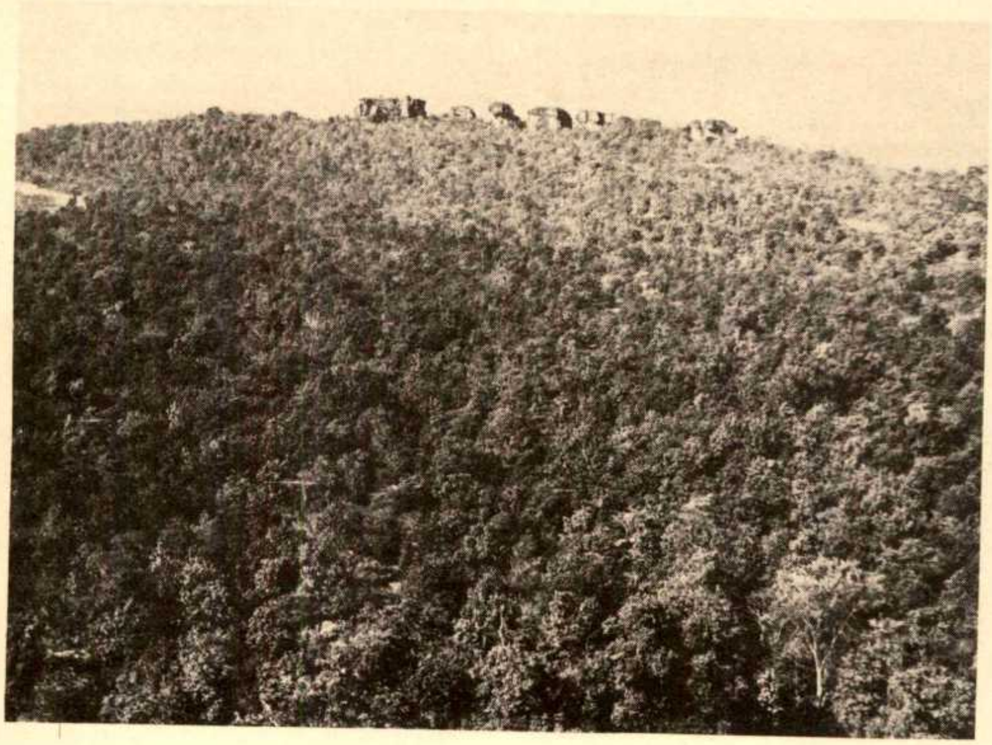

Fig. 4: Bhimbetka hill topped by a broken ridge containing rock shelters at the base, district Raisen, Madhya Pradesh. The dense dry deciduous vegetation on the hill an in the valley contains over forty plant species of food value and harbours many species of herbivore and cornivores. Several perennial springs at the foot of the hill were probably active in the past as well

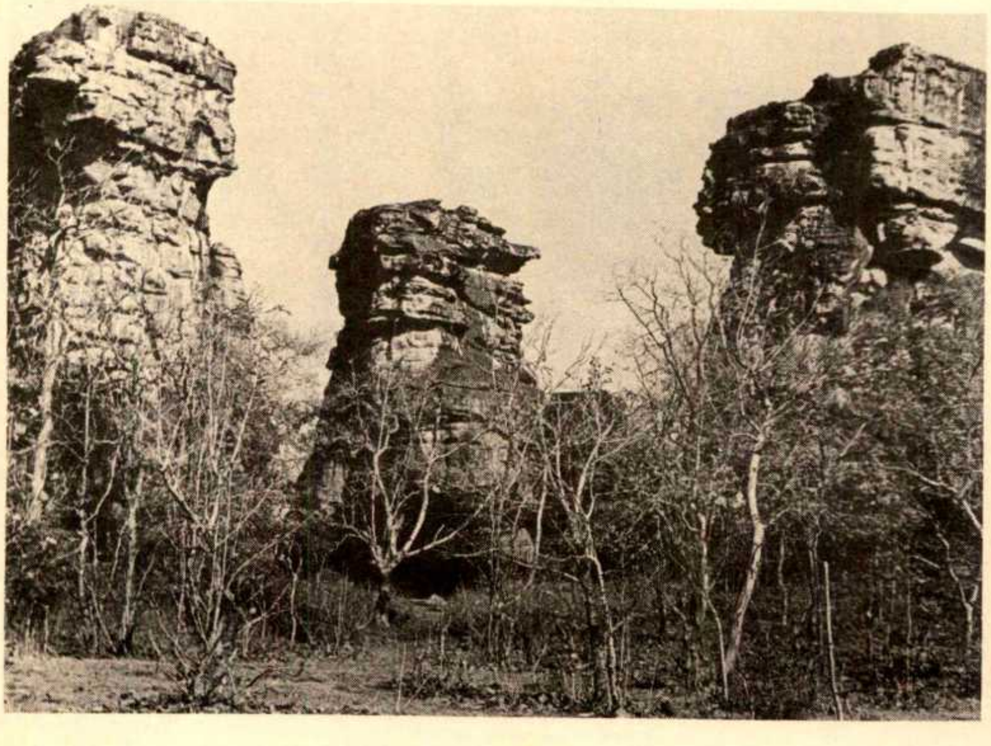

Fig. 5: A close-up of a section of the broken ridge showing shelters at the base of the monolithic rocks on the left and in the centre

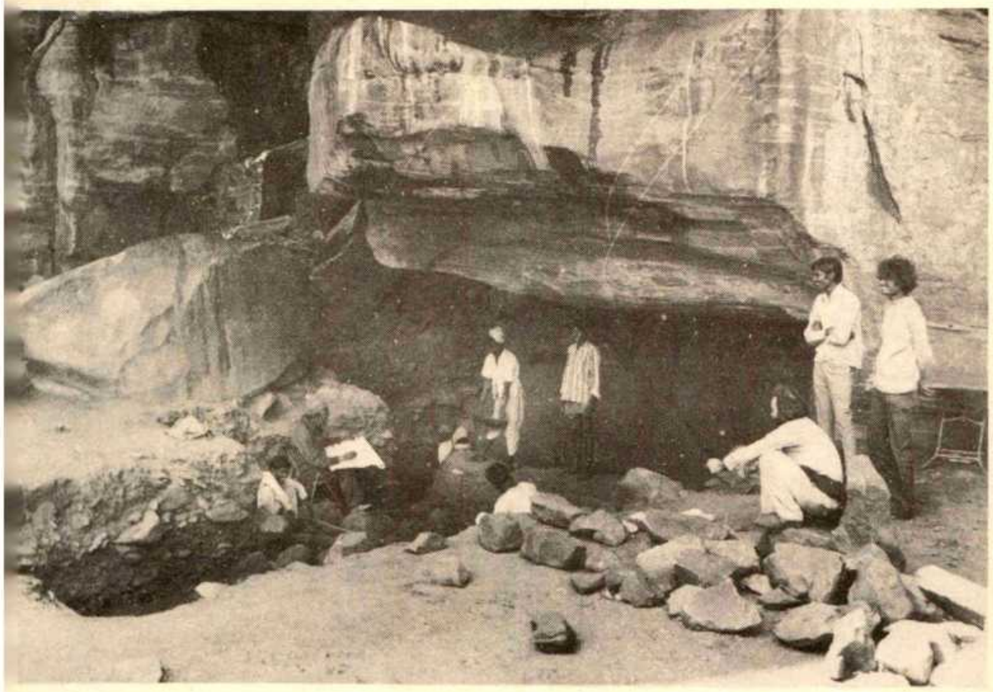

Fig. 6: Rock shelter IIIF-23 at Bhimbetka during excavation. The shelter was occupied from Lower Palaeolithic to the end of Mesolithic

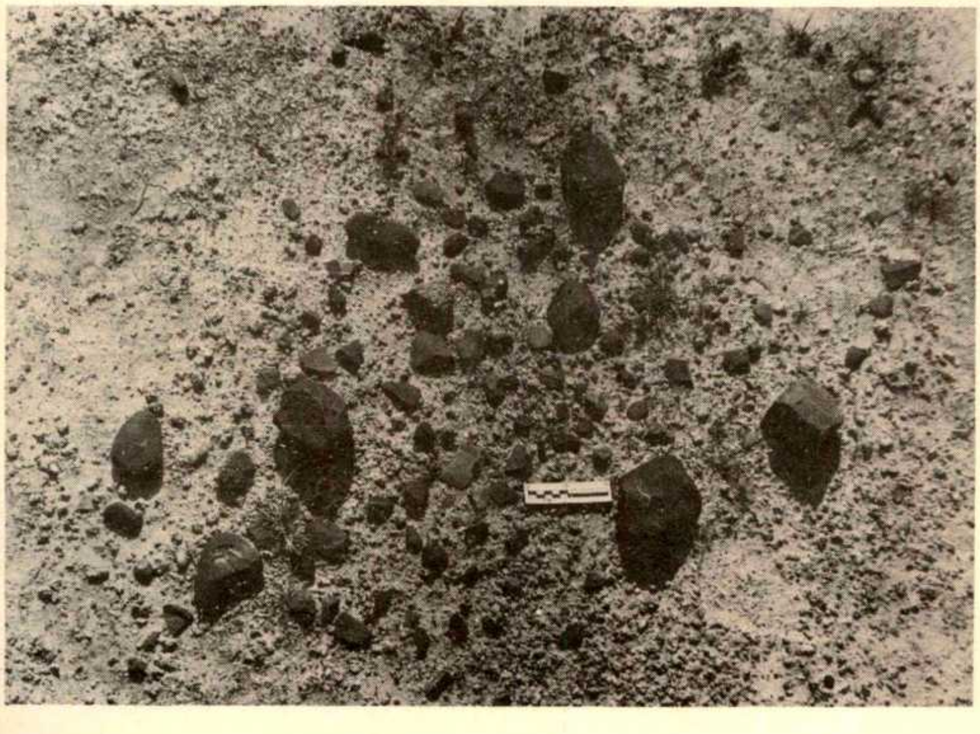

Fig. 7: An Acheulian artefact manufacturing locus close to Guravarajupalli lake at Renigunta, district Chittoor, Andhra Pradesh. The cluster contains artefacts in different stages of finishing along with debitage. The artefacts, made of quartzite, show no sign of displacement since they were made. Such clusters are common in the Tirupati valley

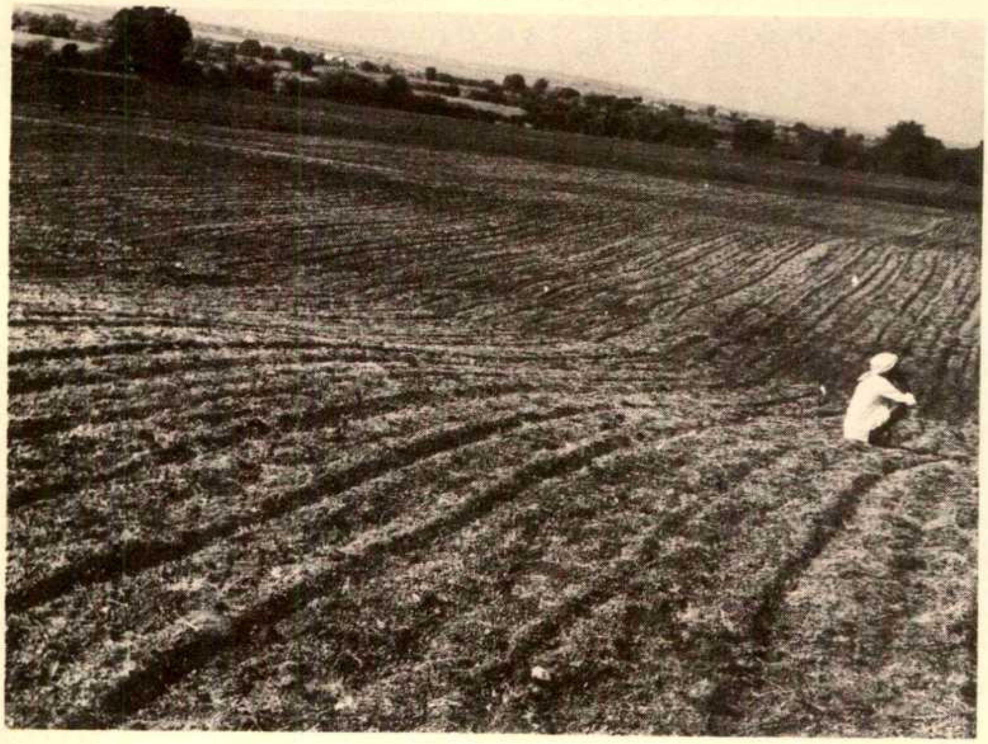

Fig. 8: Open air Acheulian site in the Hunsgi valley, district Gulbarg Karnataka. The valley, enclosed b limestone plateau on the west and south and by granite hills on the east, is drained by several seasonal streams and has several perennial springs. It has been occupied by man continuously from early Acheulian times. Acheulian sites o different stages occur buried under alluvium and are now being expos by intense agricultural activity in the valley. Acheulian people made their tools primarily of limestone but occasionally also of granite an basalt

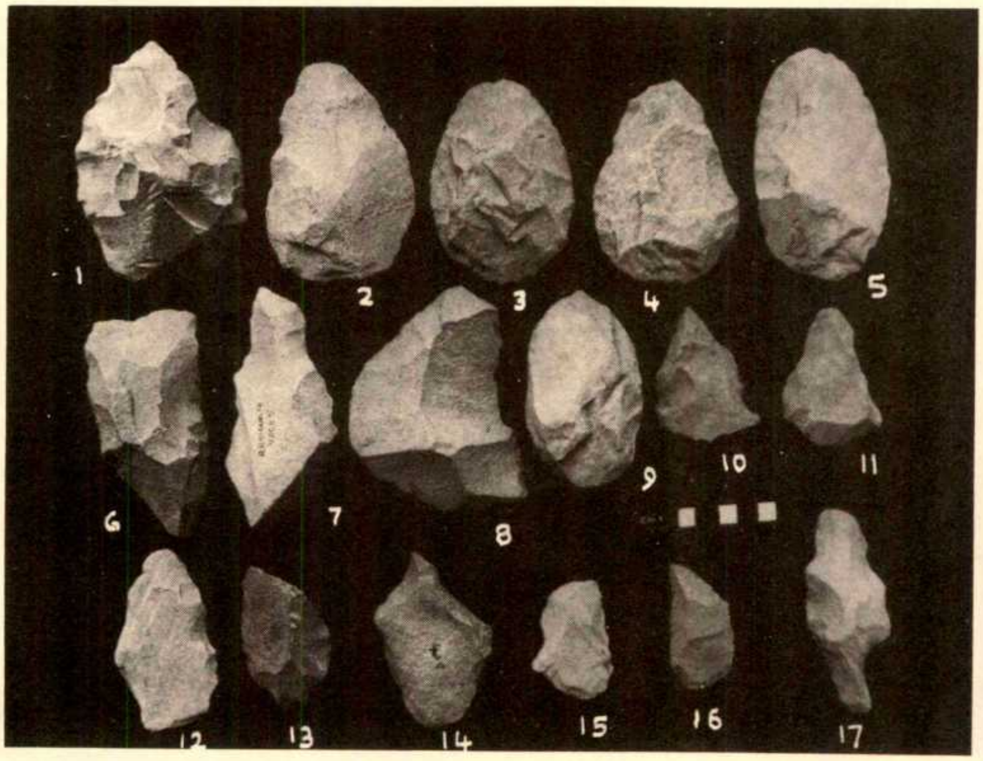

Fig. 20: Middle Palaeolithic artefacts on coarse and fine-grained quartzite from Renigunta:
1-5, handaxes;
6, cleaver;
7, chisel-edged tool;
8-9, side scrapers;
10-13, Levallois flakes;
14-15, borers;
16, Levallois point;
17, bifacial tanged point

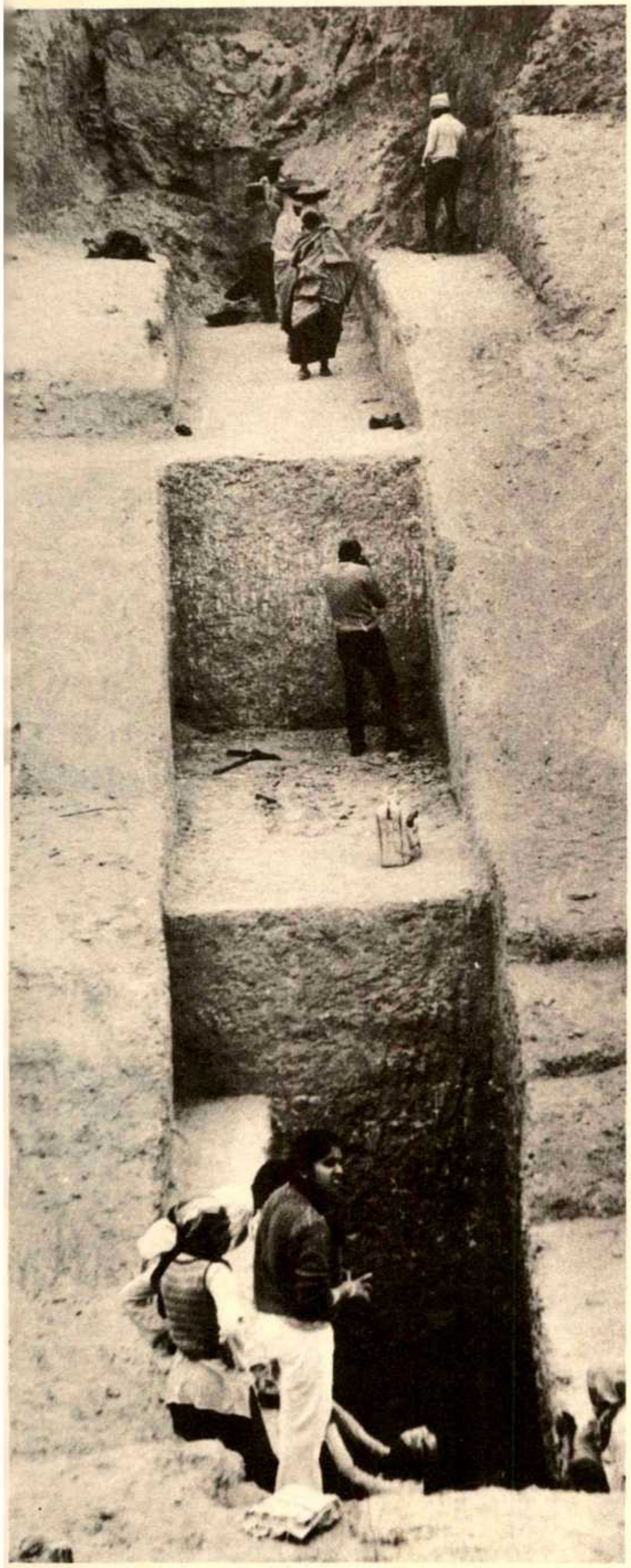

Fig. 9: Profile of the dune excavation at 16R locality, near Didwana, district Nagaur, Rajasthan. Preserved in the profile is a history of sand deposition and stabilization over a period of more than 200,000 years. Human groups occupied the stable dune surface on several occasions from Lower Palaeolithic to Mesolithic

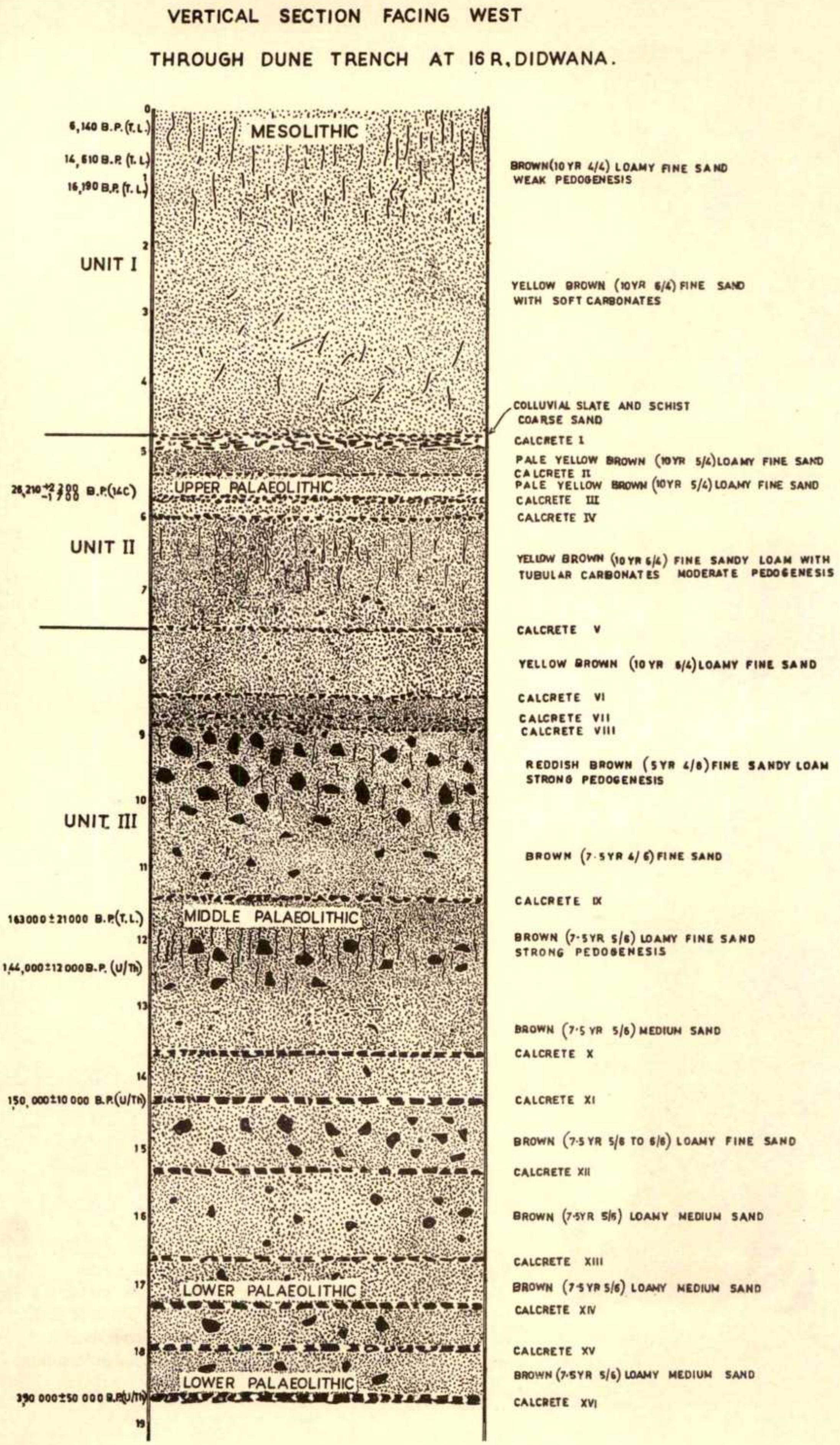
VERTICAL SECTION FACING WEST
THROUGH DUNE TRENCH AT 16 R, DIDWANA.
0
6,140 B.P. (T.L.)
14,610 B.P. (T.L.)
1
16,190 B.P. (T.L.)
MESOLITHIC
BROWN (10 YR 4/4) LOAMY FINE SAND
WEAK PEDOGENESIS
2
UNIT I
YELLOW BROWN (10YR 6/4) FINE SAND
WITH SOFT CARBONATES
3
4
COLLUVIAL SLATE AND SCHIST
COARSE SAND
CALCRETE I
5
PALE YELLOW BROWN (10YR 5/4) LOAMY FINE SAND
CALCRETE II
28,210 +2 300 -1 700 B.P. (14C)
UPPER PALAEOLITHIC
PALE YELLOW BROWN (10YR 5/4) LOAMY FINE SAND
CALCRETE III
6
CALCRETE IV
UNIT II
YELLOW BROWN (10 YR 6/4) FINE SANDY LOAM WITH
TUBULAR CARBONATES MODERATE PEDOGENESIS
7
CALCRETE V
8
YELLOW BROWN (10 YR 6/4) LOAMY FINE SAND
CALCRETE VI
CALCRETE VII
CALCRETE VIII
9
REDDISH BROWN (5YR 4/8) FINE SANDY LOAM
STRONG PEDOGENESIS
10
UNIT III
BROWN (7.5YR 4/6) FINE SAND
11
CALCRETE IX
163000 ± 21000 B.P. (T.L.)
MIDDLE PALAEOLITHIC
12
BROWN (7.5YR 5/6) LOAMY FINE SAND
STRONG PEDOGENESIS
1,44,000 ± 12 000 B.P. (U/Th)
13
BROWN (7.5 YR 5/6) MEDIUM SAND
CALCRETE X
14
150,000 ± 10 000 B.P. (U/Th)
CALCRETE XI
15
BROWN (7.5 YR 5/8 TO 6/6) LOAMY FINE SAND
CALCRETE XII
16
BROWN (7.5YR 5/6) LOAMY MEDIUM SAND
CALCRETE XIII
17
LOWER PALAEOLITHIC
BROWN (7.5 YR 5/6) LOAMY MEDIUM SAND
CALCRETE XIV
18
CALCRETE XV
LOWER PALAEOLITHIC
BROWN (7.5YR 5/6) LOAMY MEDIUM SAND
390 000 ± 50 000 B.P. (U/Th)
CALCRETE XVI
19

Fig. 10: Sketch of the 16R dune section showing weathered horizons, calcretes, radiometrically dated points, and occupation levels

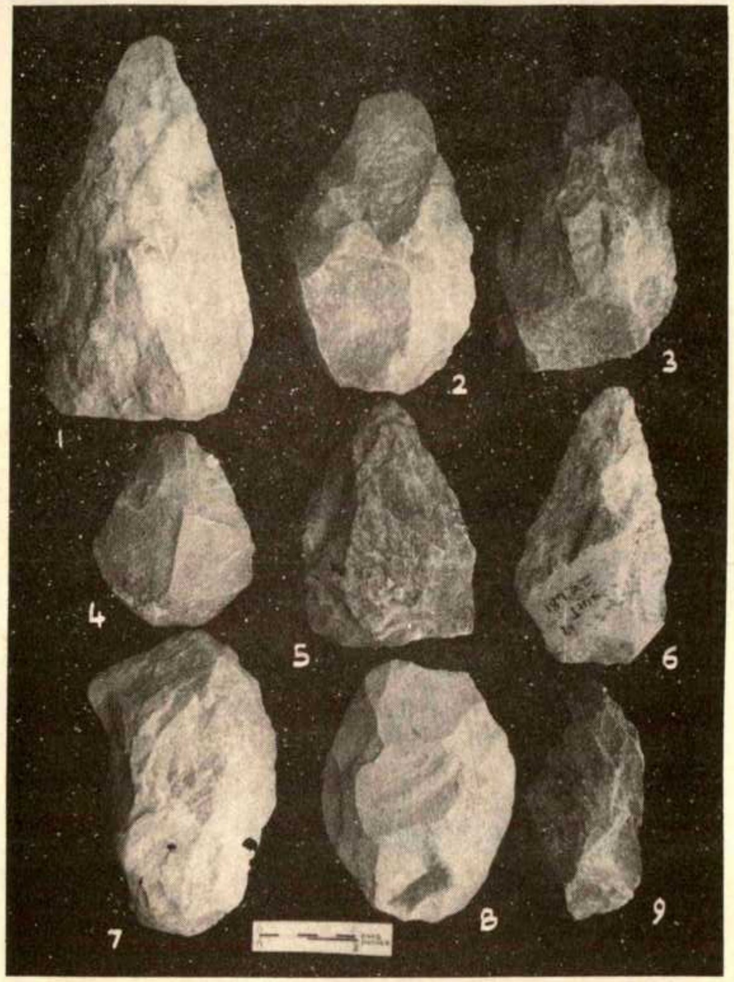

Fig. 11: Early Acheulian tools from Singi Talav, Didwana, Rajasthan: 1-6, 9, handaxes; 7-8, cleavers

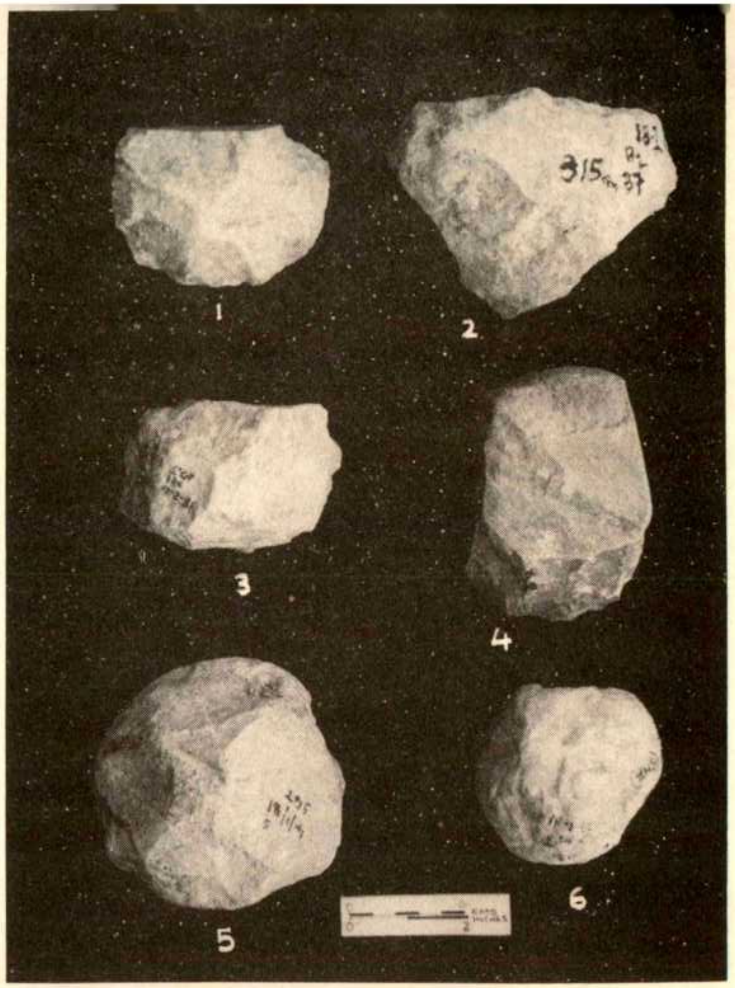

Fig. 12: Early Acheulian tools from Singi Talav: 1-4, choppers; 5-6, polyhedrons

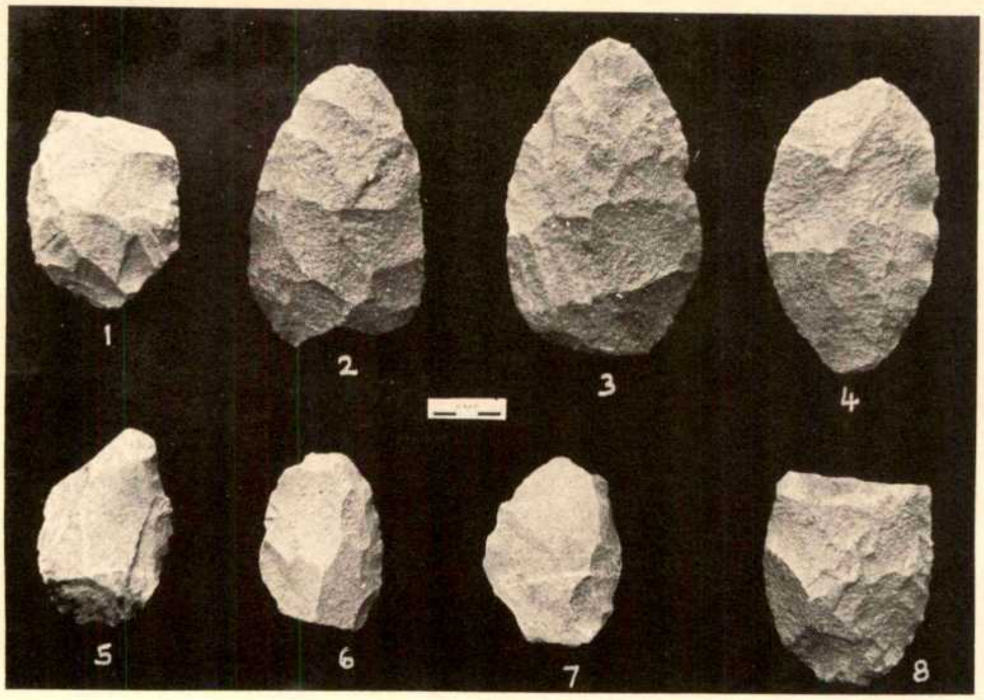

Fig. 13: Late Acheulian handaxes made on fine-grained quartzite from Bhimbetka

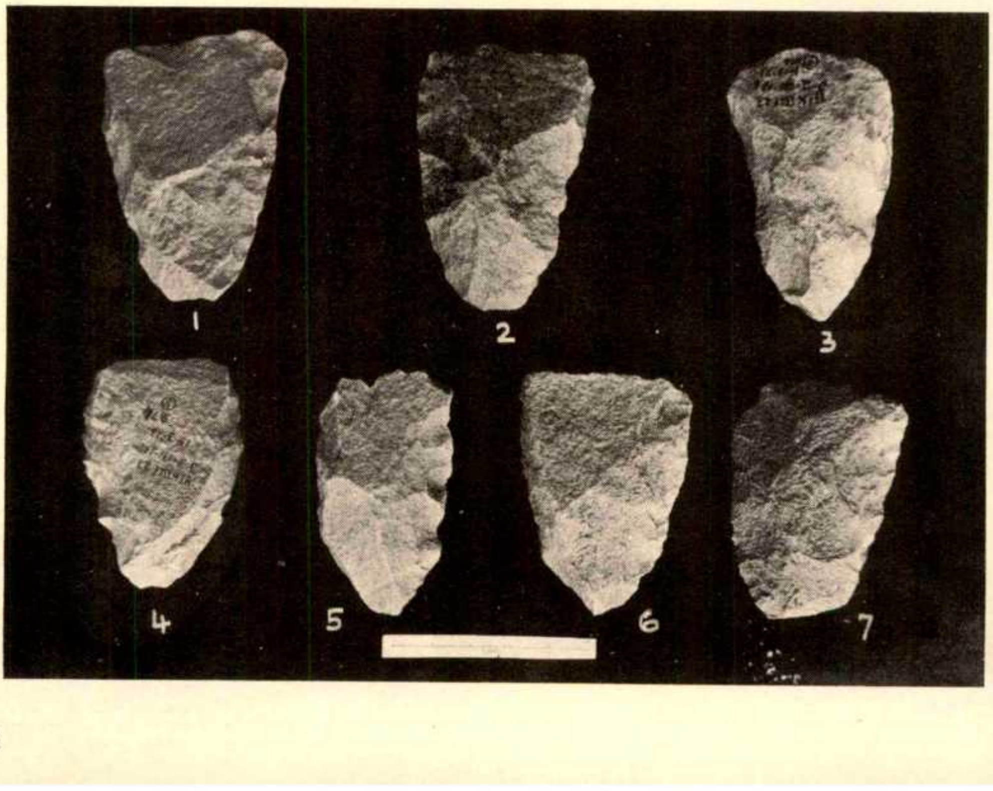

Fig. 14: Late Acheulian cleavers from Bhimbetka

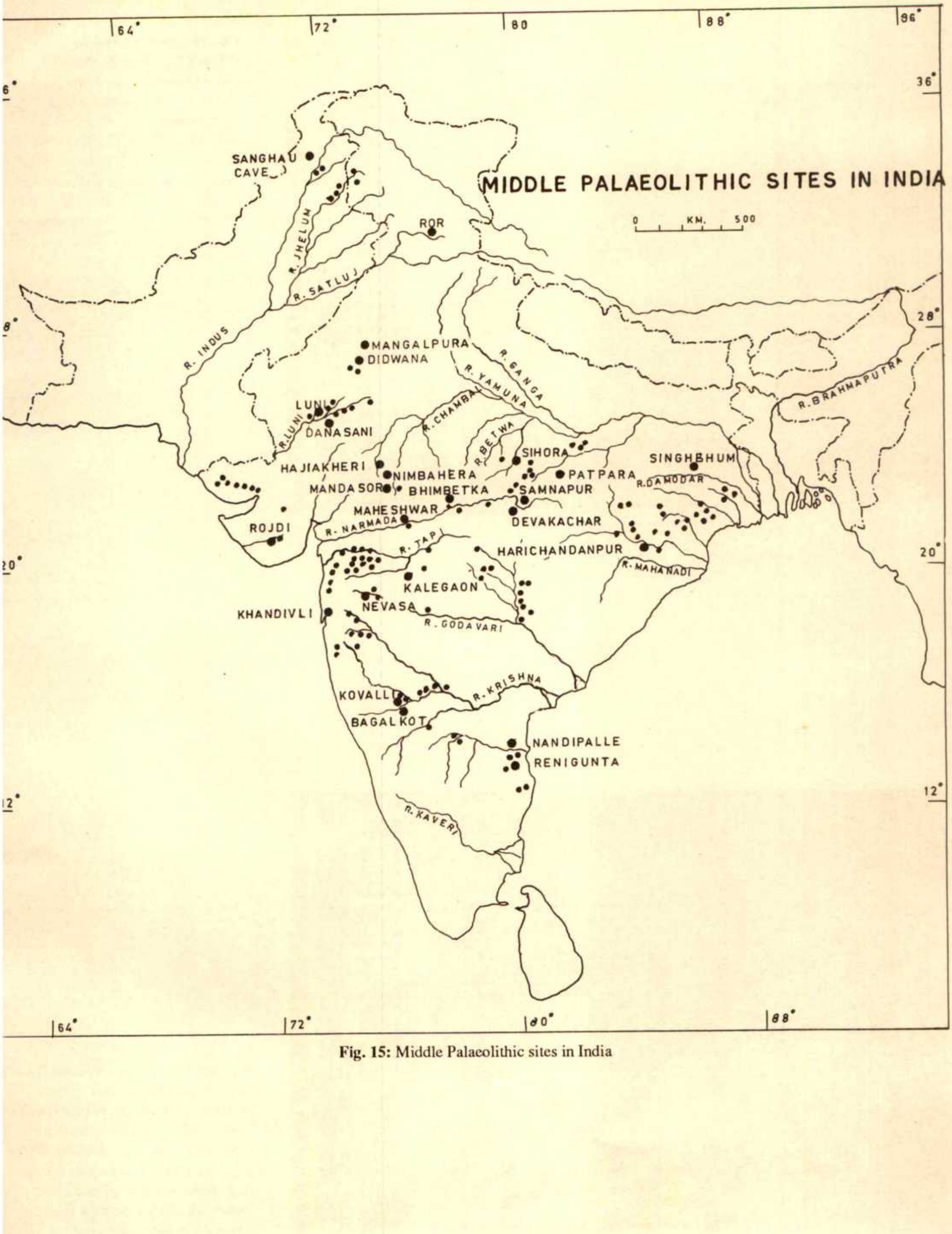

Fig. 15: Middle Palaeolithic sites in India

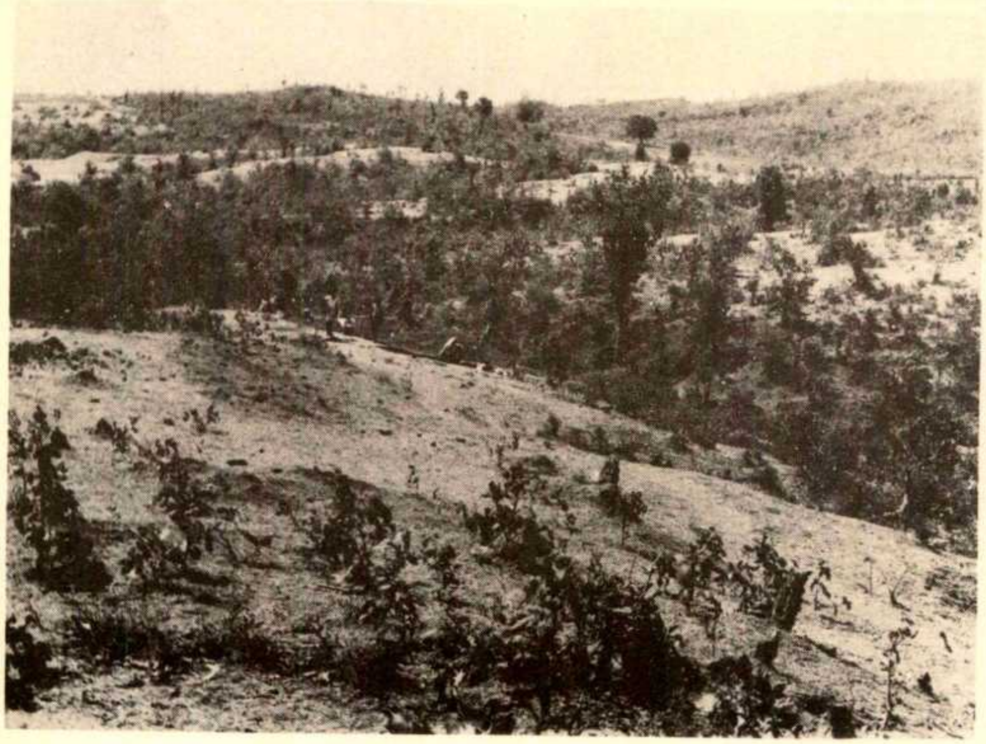

Fig. 16: Open-air Middle Palaeolithic site at Samnapur, district Narsinghpur, M.P. The people camped here on a high alluvial terrace of the Narmada river abutting the Vindhyan hills. The location provided protection from the river floods and easy availability of chert from the hill for making tools. After its abandonment the site got buried under over 12 m thick river silt

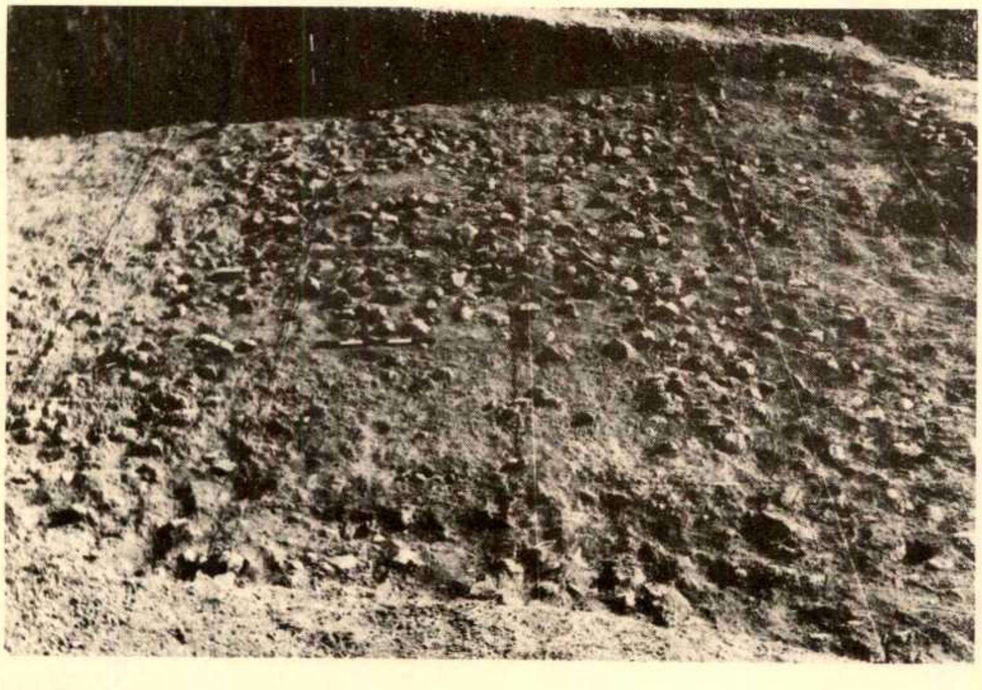

Fig. 17: Part of an occupation floor at Samapur. It contains artefacts, chert cobbles and occasional fossil bones and teeth. The occupants primarily used chert, available on the adjacent hill, for making their tools, but occasional also quartzite and basalt which they brought from several kilometres distance

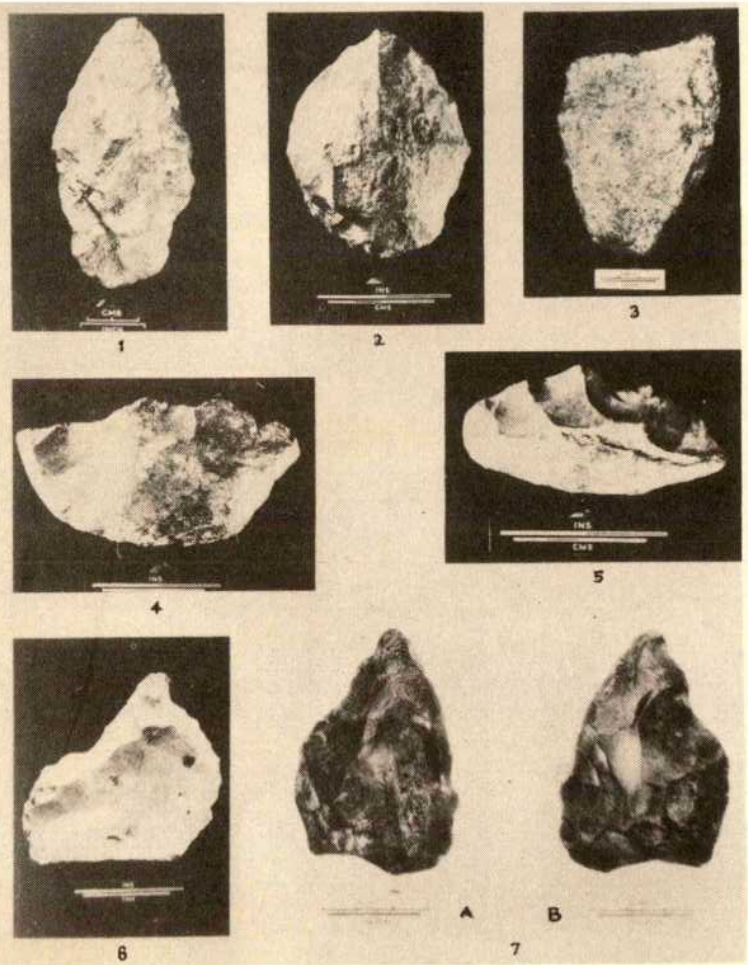

Fig. 18: Middle Palaeolithic artefacts from Luni valley, western Rajasthan: 1-2, handexes; 3, cleavers; 4-5, side scrapers; 6, borer; 7a-b, bifacial point. 1, 3, rhyolite; remaining chert

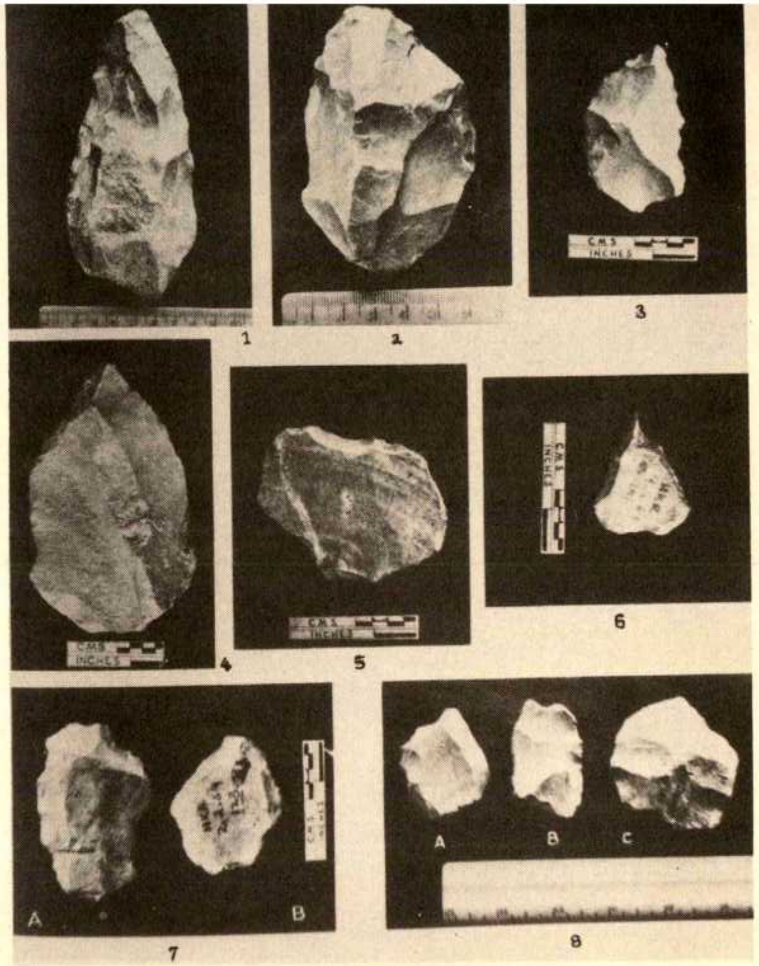

Fig. 19: Middle Palaeolithic artefacts from the Wagan valley, eastern Rajasthan: 1-2, handaxes; 3-4, points; 5, single side flake scraper; 6, borer; 7a, double side flake scraper; 7b, sub-triangular point with broken tip; 8a-c, core scrapers

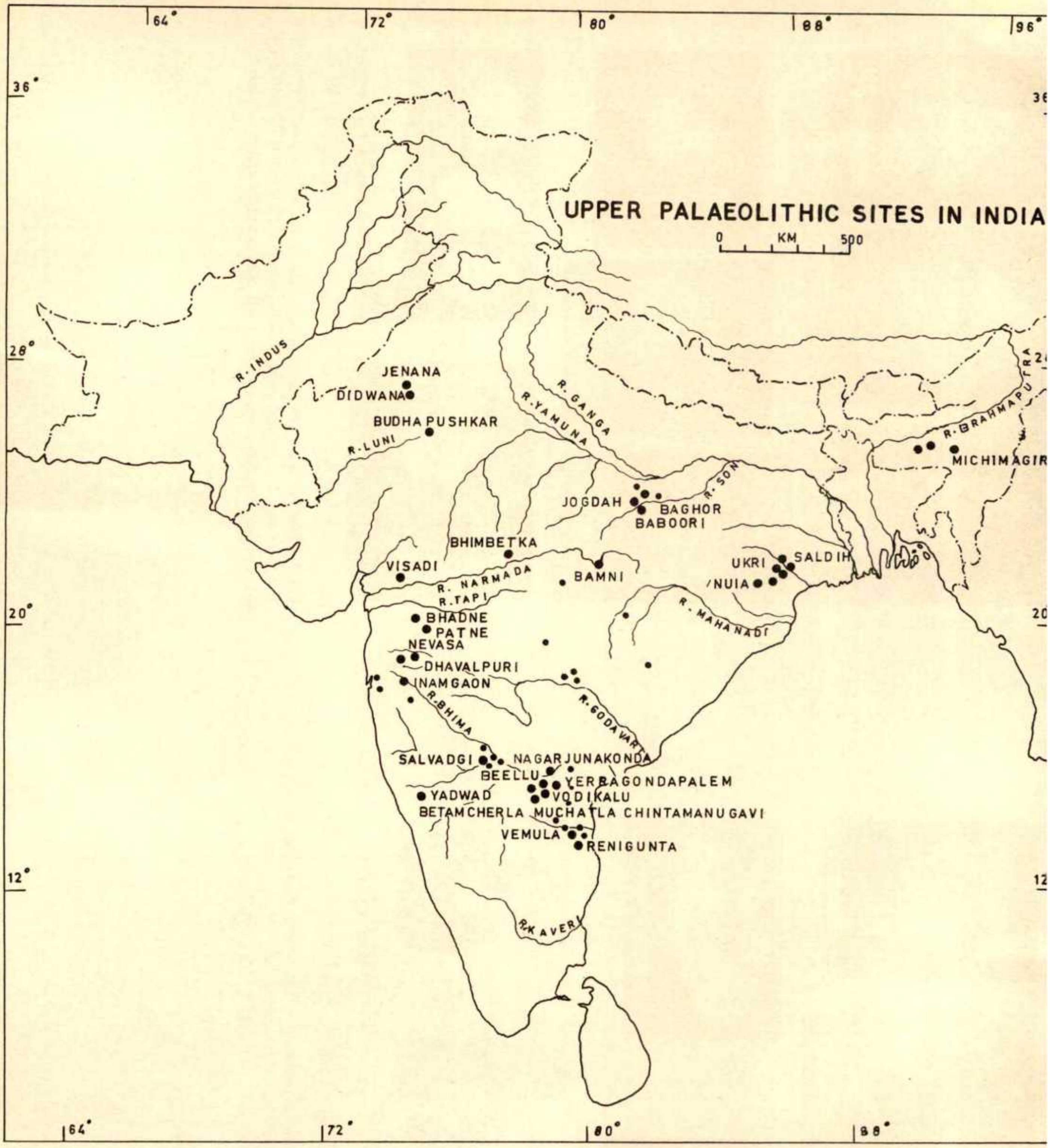

Fig. 21: Upper Palaeolithic sites in India

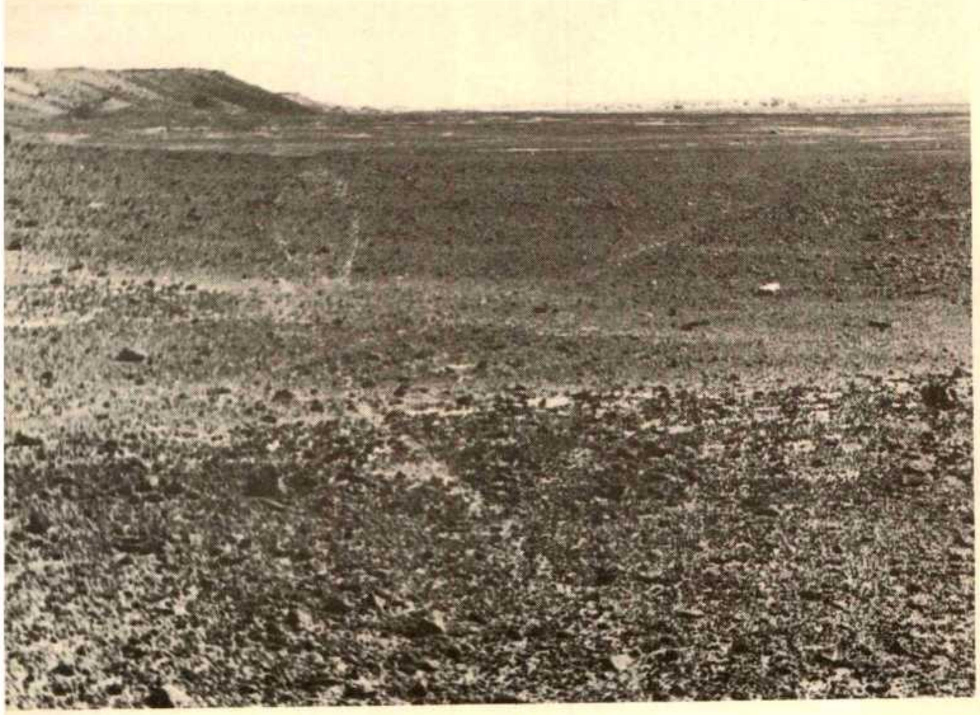

Fig. 22: A wide palaeochannel at Mokal, north of Jaisalmer, Rajasthan. An Upper Palaeolithic site occurs on the slope of the rocky bank. The preservation of such channels without the enchroachment of sand and of Upper Palaeolithic sites along them strongly suggests that Himalayan drainage continued to function in this part of the desert well into the Upper Pleistocene and perhaps also into the early Holocene

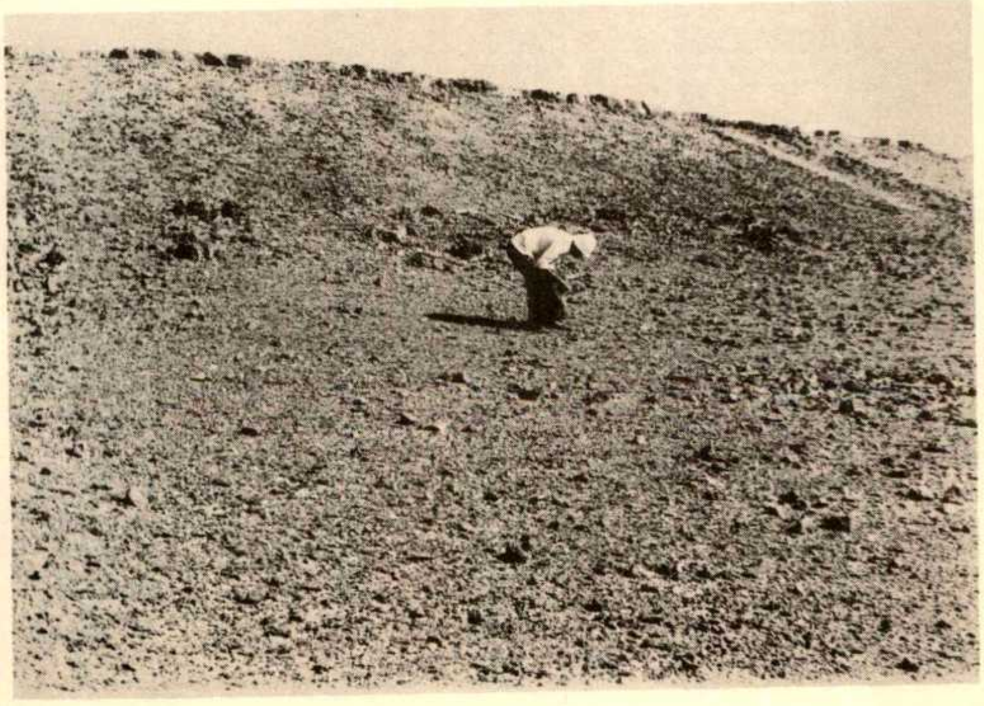

Fig. 23: Close-up of the rocky bank of the above channel with Upper Palaeolithic artefacts strewn on its slope and base

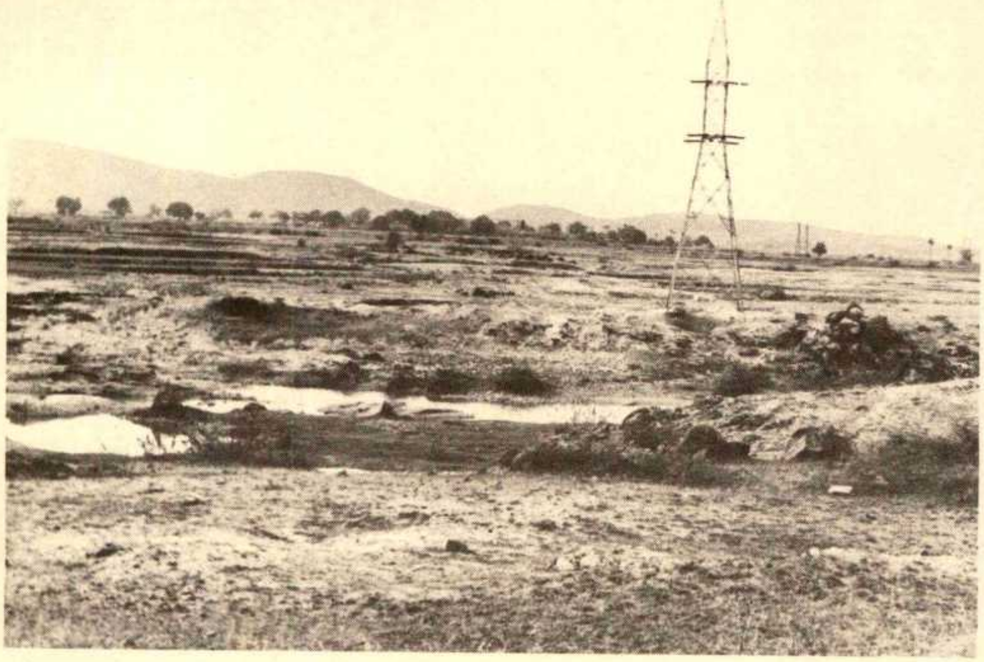

Fig. 24: Open-air Upper Palaeolithic horizontal ocupation scatter on the bank of Isukakalava, a seasonal stream, at Renigunta. Such scatters have a wide distribution along the eastern flanks of the southern Eastern Ghats

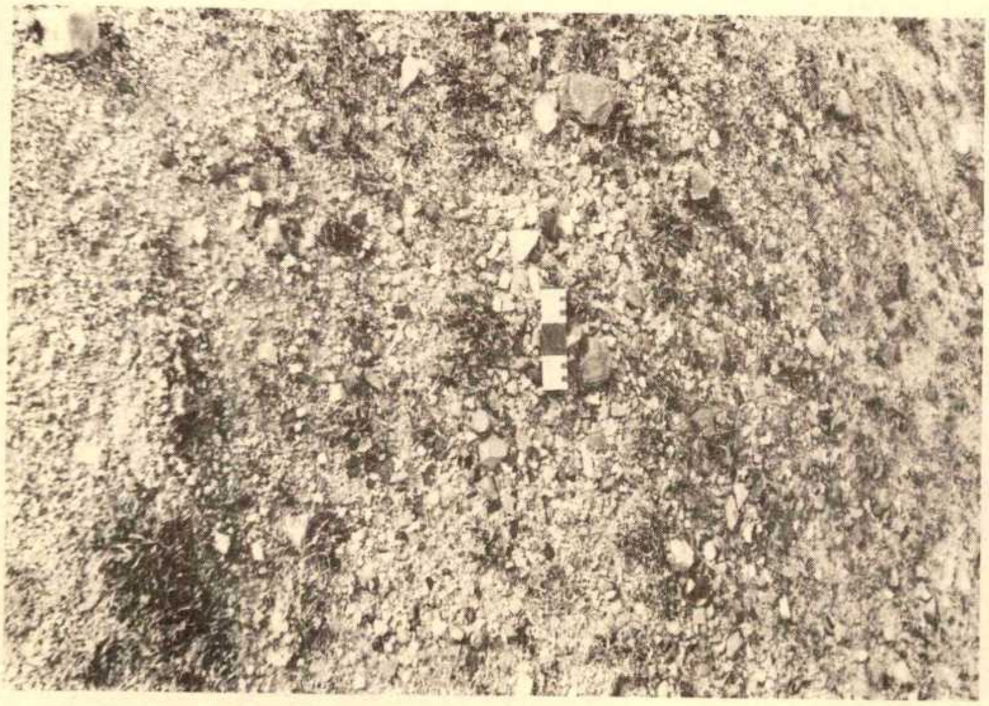

Fig. 25: Close view of the artefact scatter seen in Fig. 24. This river bank occupation has yielded flat bored stones which probably served the function of net sinkers. The Yanadis, the fisher-hunter-gatherers of this region, exploit such aquatic niches today

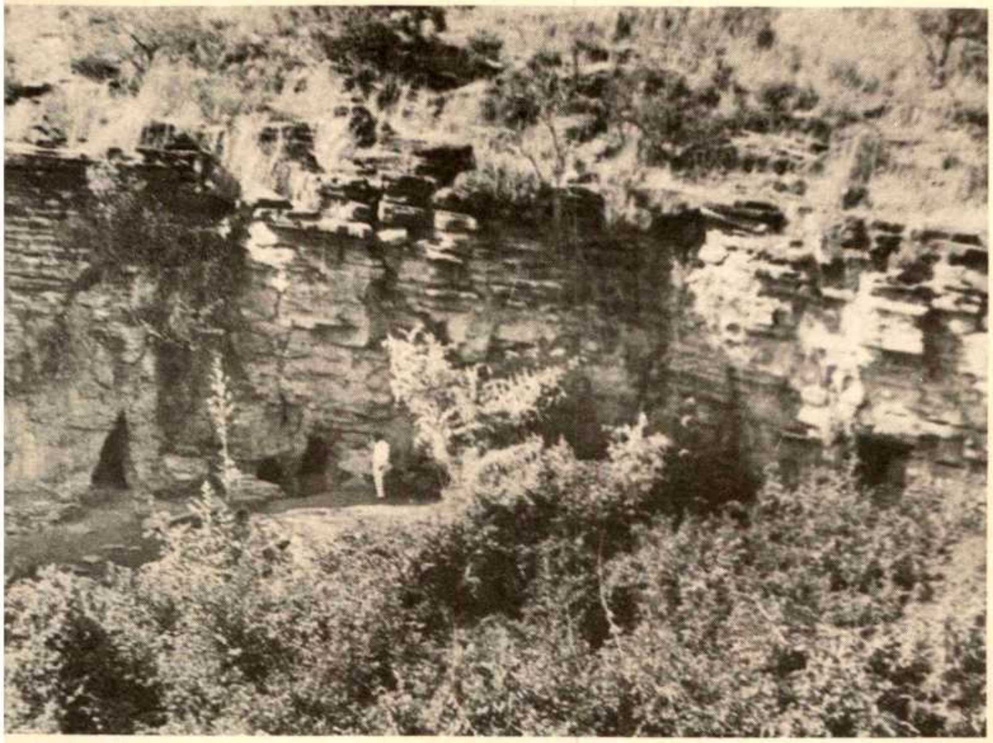

Fig. 26: Muchchatla Chintamanu Gavi (MCG), an endogene cave complex, near Betamcherla, Kurnool district, Andhra Pradesh. These caves were occupied from Upper Palaeolithic to Neolithic times. Vegetation in the valley after monsoon includes at least 30 wild plants of food value

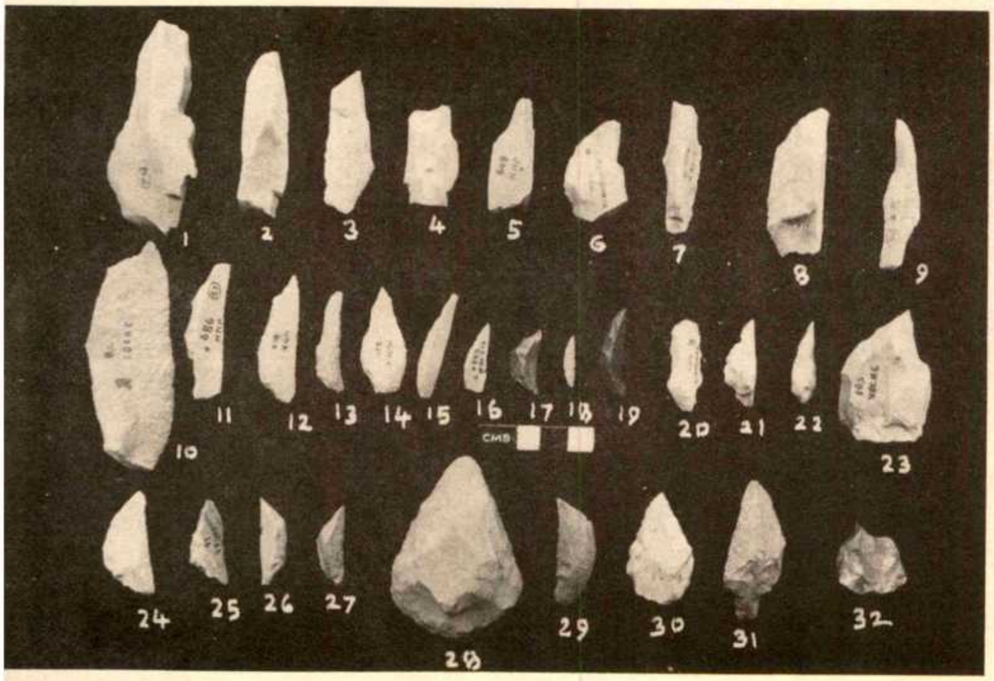

Fig. 27: Upper Palaeolithic artefacts from Renigunta:
1-9, Burins;
10, 17, 19, 24, elouera-type backed blades;
11-12, 14-16, 18, 20-22, backed blades;
13, backed blade with gibbosity;
23, blade core;
25, 27, triangles;
26, trapeze;
28, 30, unifacial points;
29, pointed blade;
31, tangged point;
32, awl.
17, 19, 32 are on lydianite, and the remaining on fine-grained quartzite

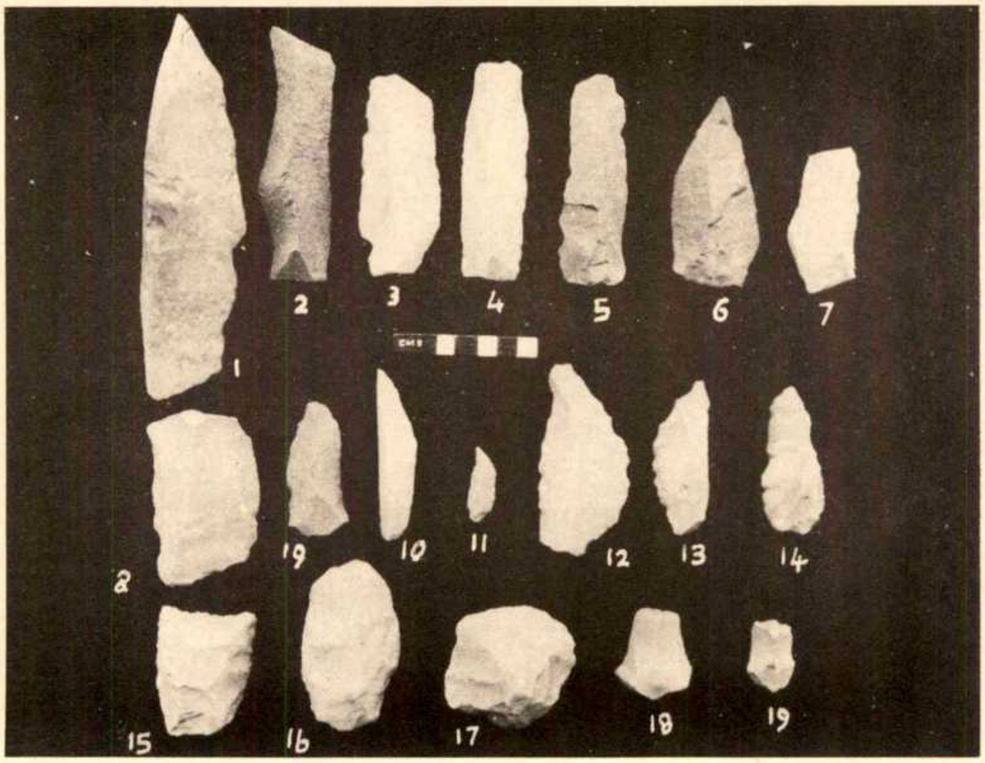

Fig. 28: Upper Palaeolithic artefacts from Renigunta:
1, large pointed blade with working on right lateral edge;
2-5, parallel-sided blades with use marks;
6, Levallois point;
7-8, straight side scrapers on blade.
9-11, pointed blades;
12-14, convex side scrapers on blade;
15, end scraper on nodule;
16, ovoid scraper;
17, round scraper;
18-19, end scrapers on blade.
All on fine-grained quartzite

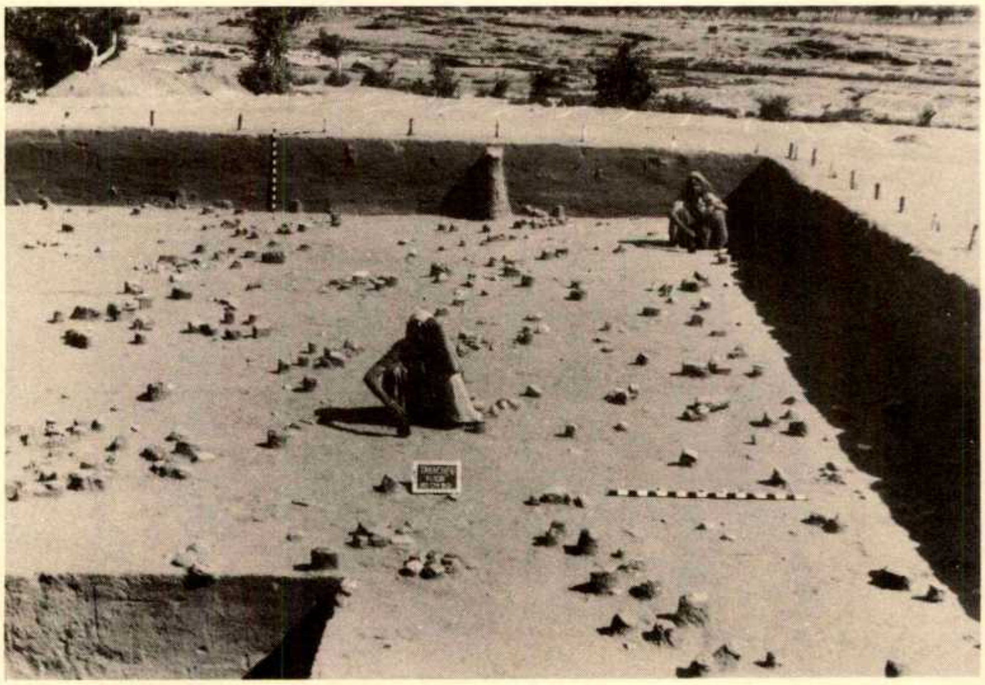

Fig. 32: Mesolithic occupation floor buried under sand at Bagor

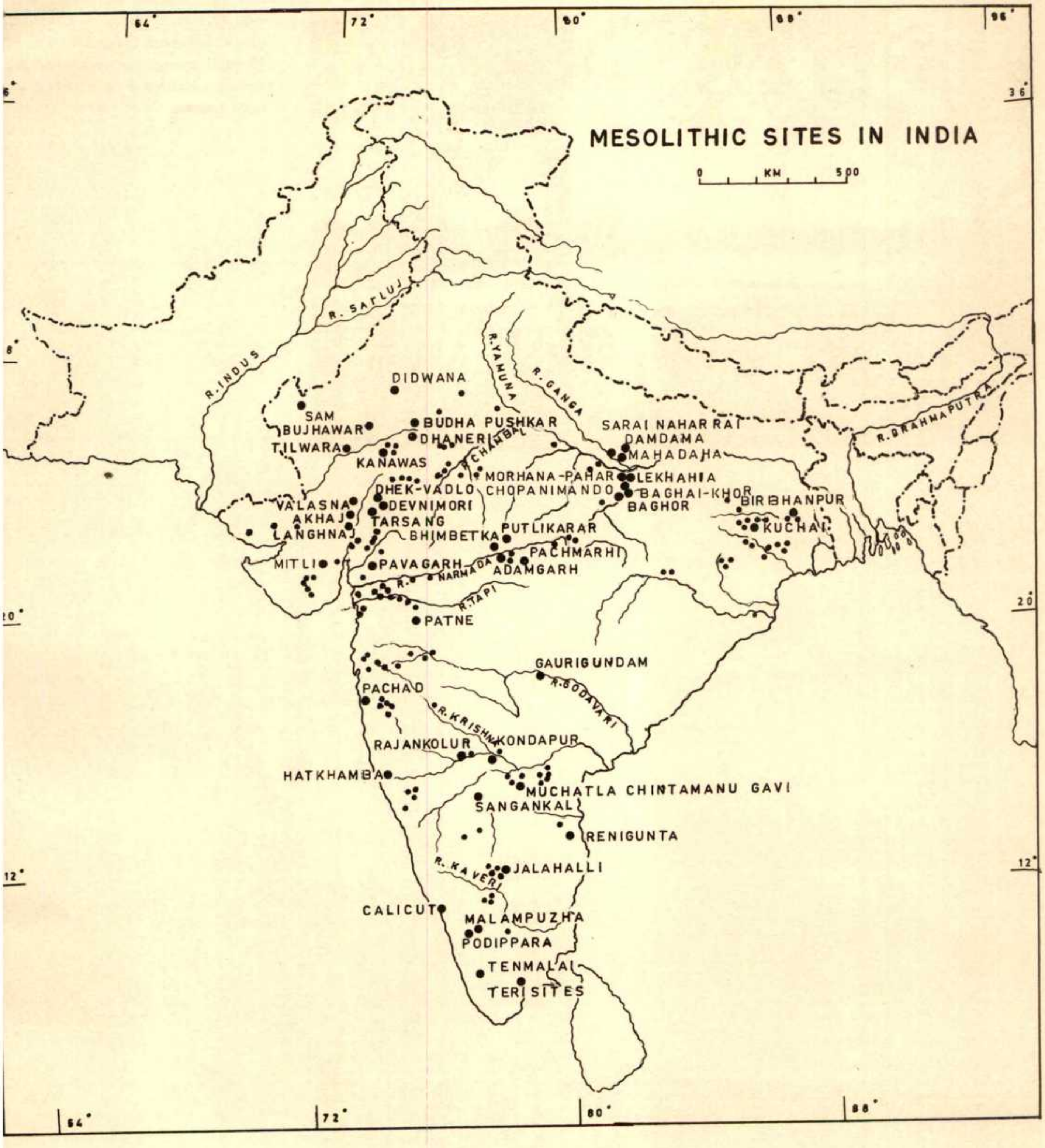

Fig. 29: Mesolithic sites in India

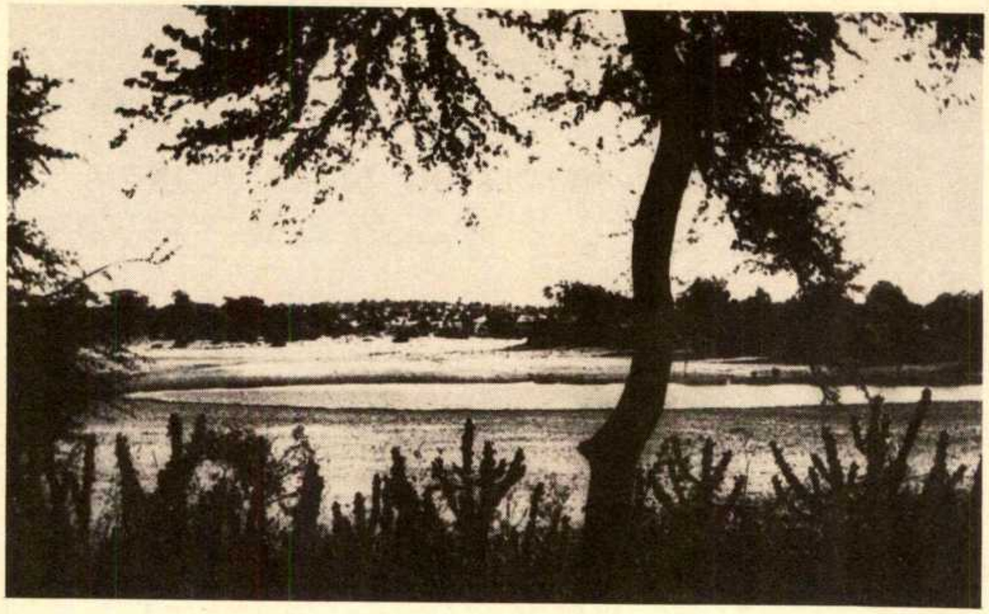

Fig. 30: Interdunal lake at Langhnaj, district Mehsana, Gujarat. Mesolithic people settled on the dunes around many such lakes in north Gujarat

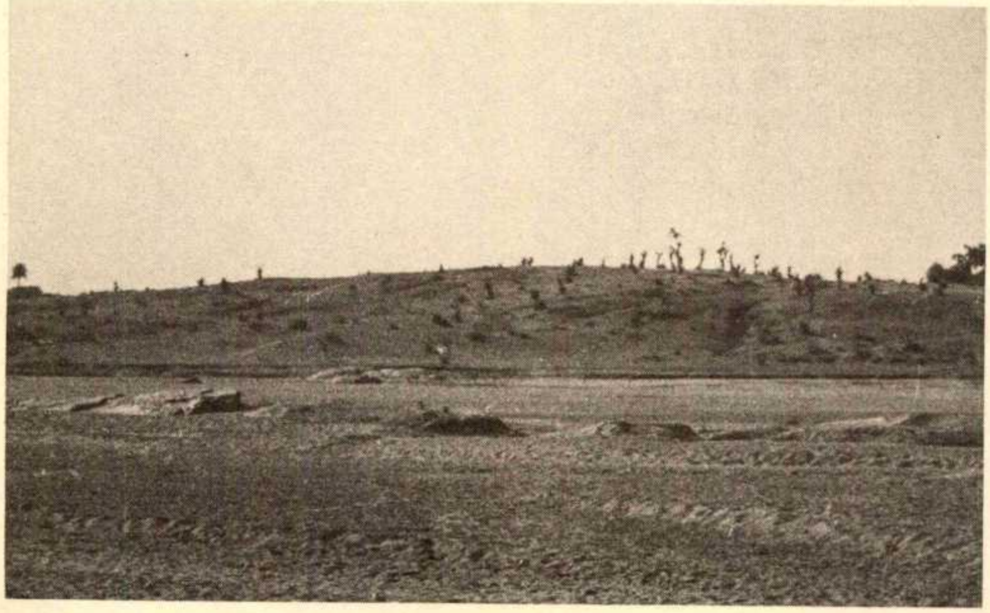

Fig. 31: Mesolithic occupation dune on the bank of Kothari river at Bagor, district Bhilwara, Rajasthan

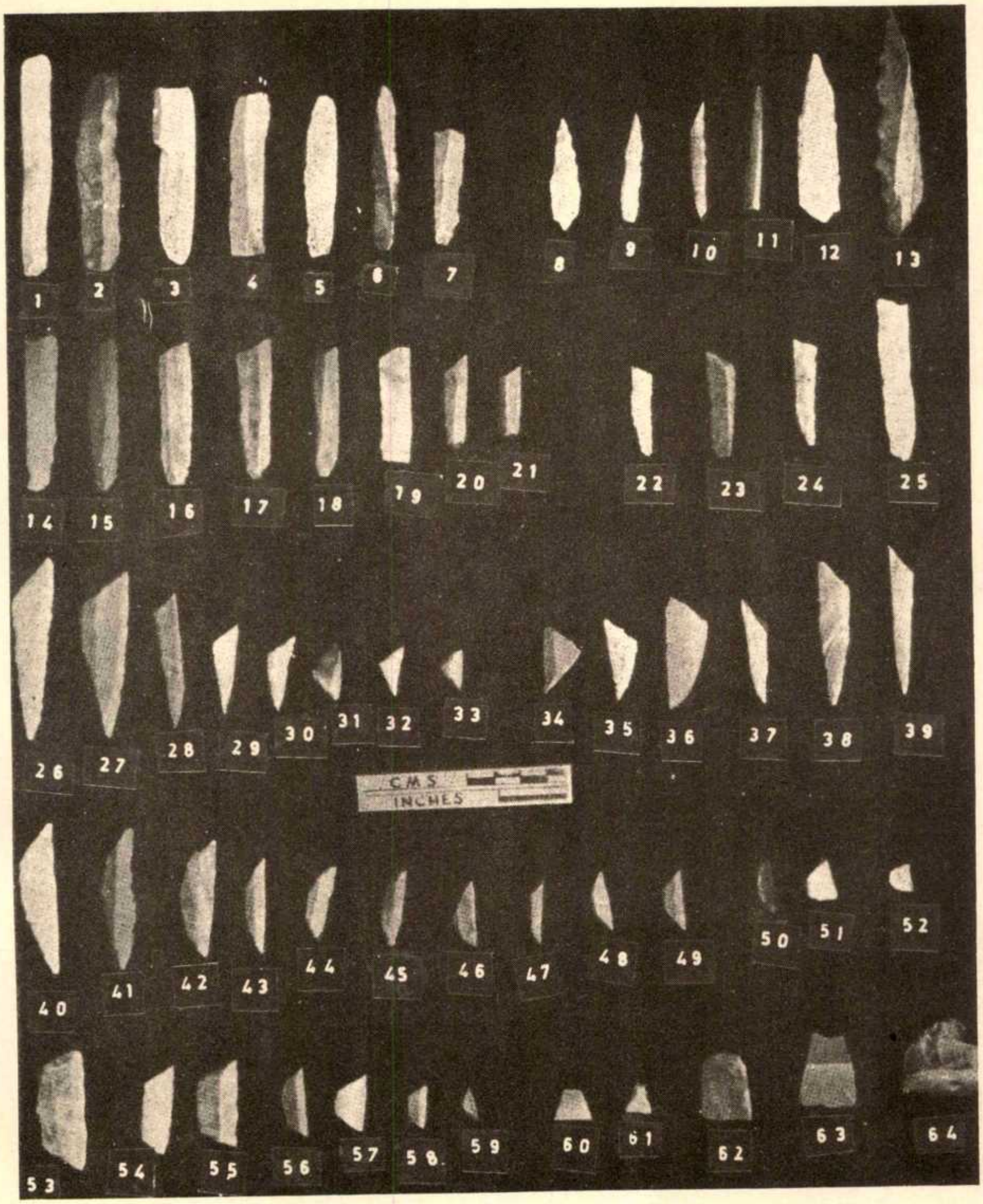

Fig. 33: Microlithic tools from Bagor, district Bhilwara, Rajasthan: 1-7, blades; 10-12, points; 13, serrated blade; 14-25, obliquely truncated blades; 26-39, triabgles; 40-52, lunates; 53-64, trapezes

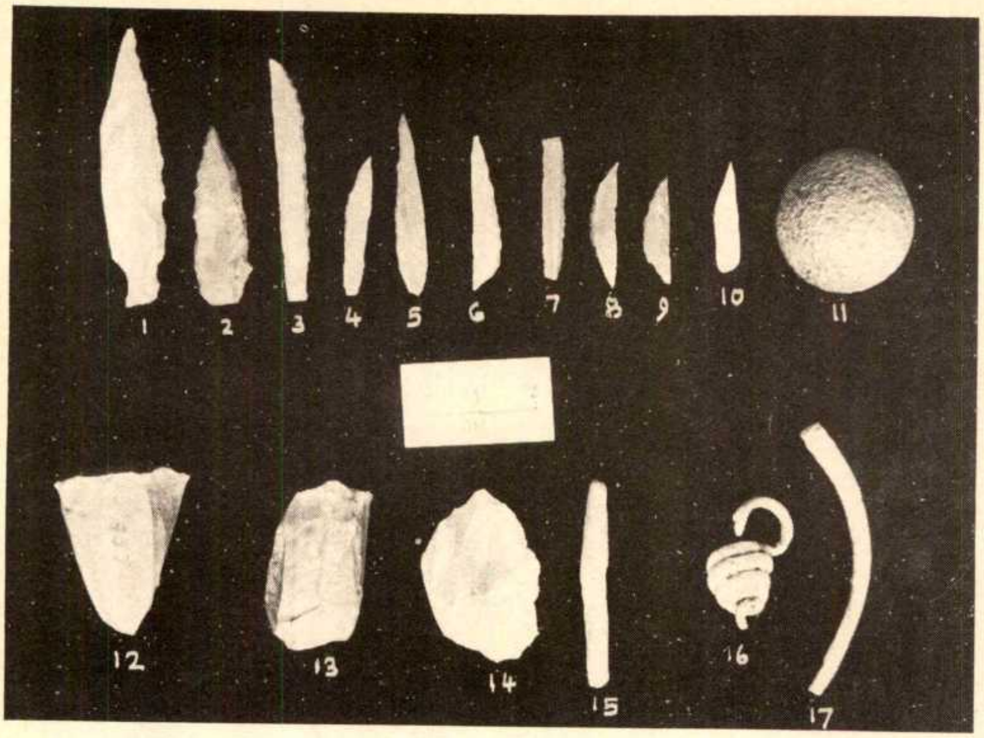

Fig. 34: Late Mesolithic artefacts from Muchchatla Chintamanu Gavi II, Betamcherla:
1, shouldered point;
2, retouched blade;
3-5, 7, blunted back blades;
6, triangle;
8-9, lunates;
10, perforator;
11, sling ball (finished by grinding);
12-13, fluted cores;
14, side scraper;
15, copper antimony rod;
16, copper spiral ear ring;
17, copper bangle fragment.
Copper objects (No. 15-17) occur in the late Mesolithic levels and are typical of the nearby Neolithic-Chalcolithic settlements such as Ramapuram

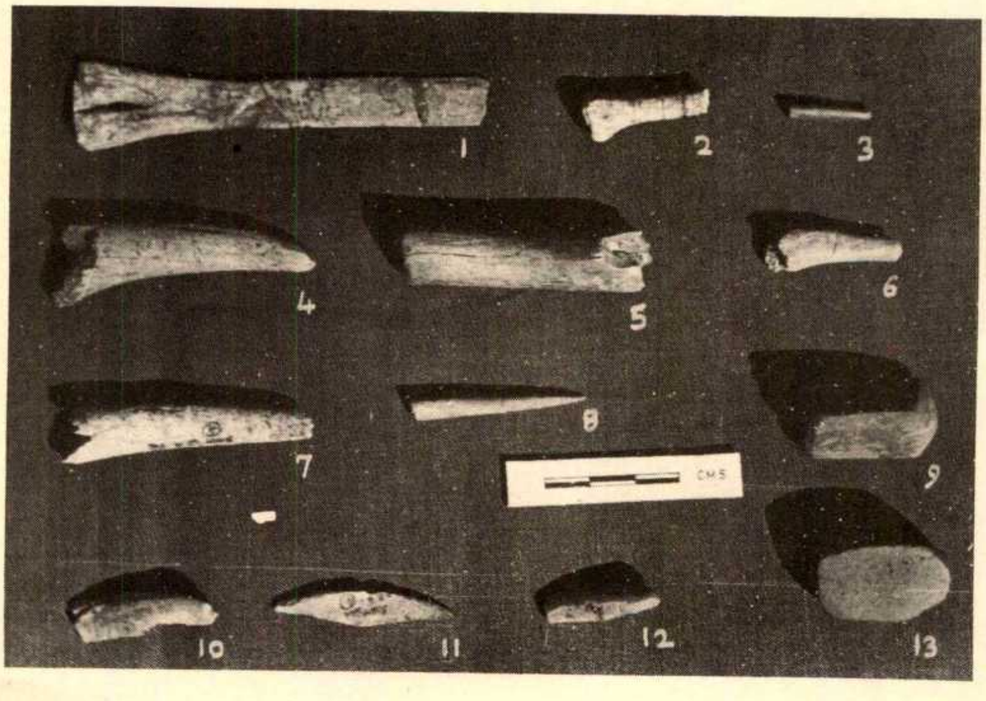

Fig. 35: Bone and antler artefacts (Nos. 1-8, 10-12) and pieces of haematite with ground surfaces (Nos. 9, 13) from Mesolithic deposits at Bhimbetka

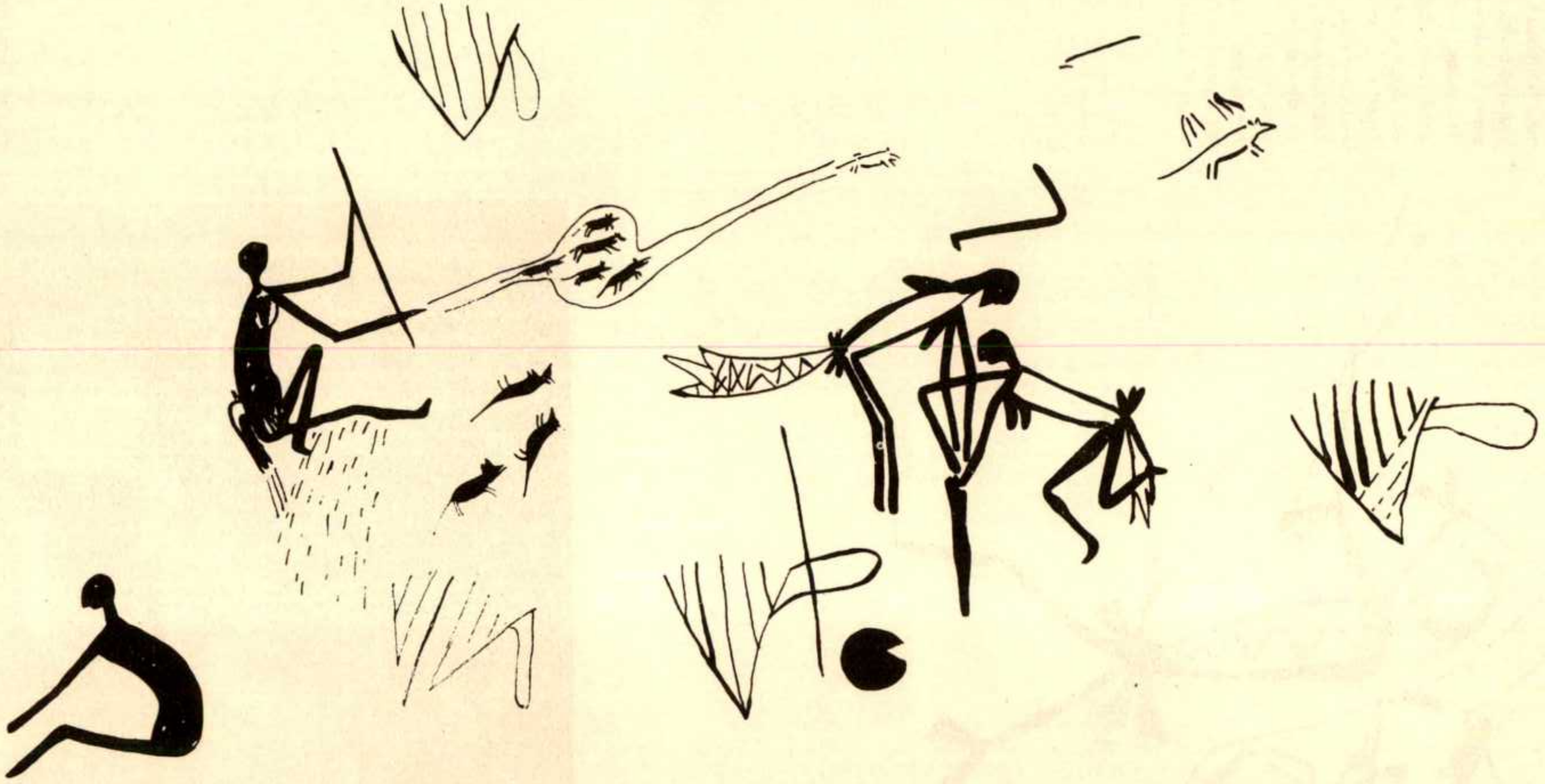

Fig. 36: Rock painting from Jaora near Bhimbetka depicting a hunter with basket or carrying net filled with different animals from the forest and river. The peculiar shape of his head is either due to a mask or simply the stylized treatment. The hunter has decorative bands on his elbows and also around one of his knees. He carries a bow and tow arrows, one tipped with mocroliths, the other with a ball-shaped stabilizing weight. (After Neumayer 1983)

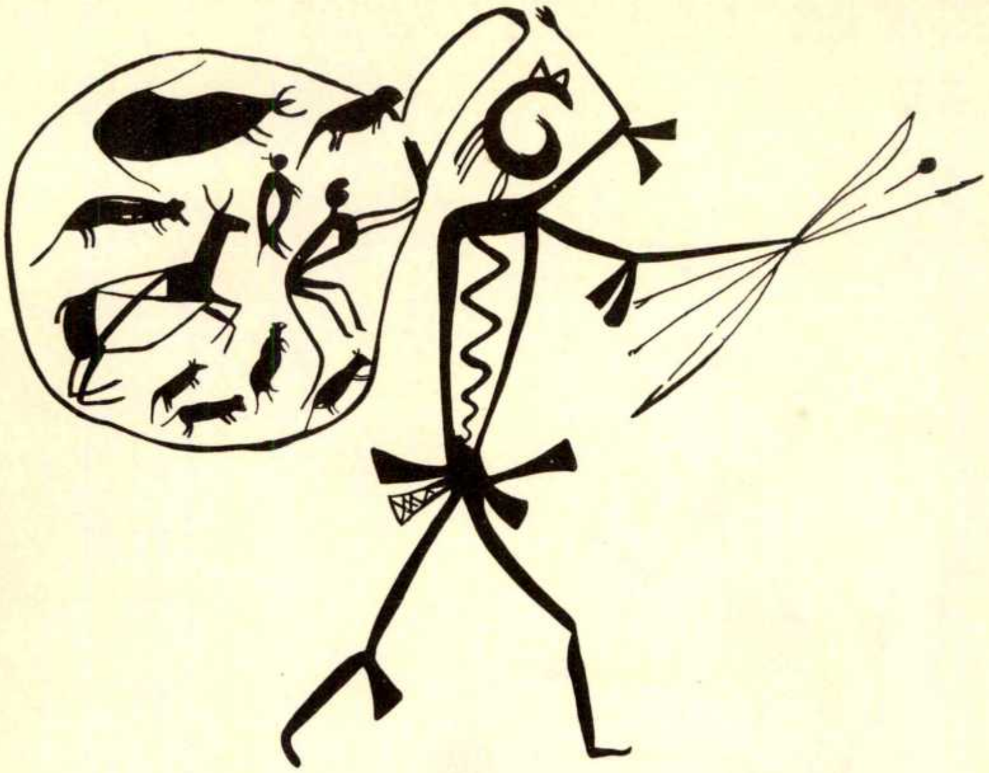

Fig. 37: Rock painting from Jaora near Bhimbetka depicting women engaged in catching rats. The rat-hole is shown in X-ray style. The women to the left of the hole excavates the rat-hole with the help of a digging stick and has already killed a number of rats. The excavated material is shown by dots below her feet. Two women to the right are engaged in digging something. There are four V-shaped baskets and a digging stick around the scene of action. (After Neumayer 1983)

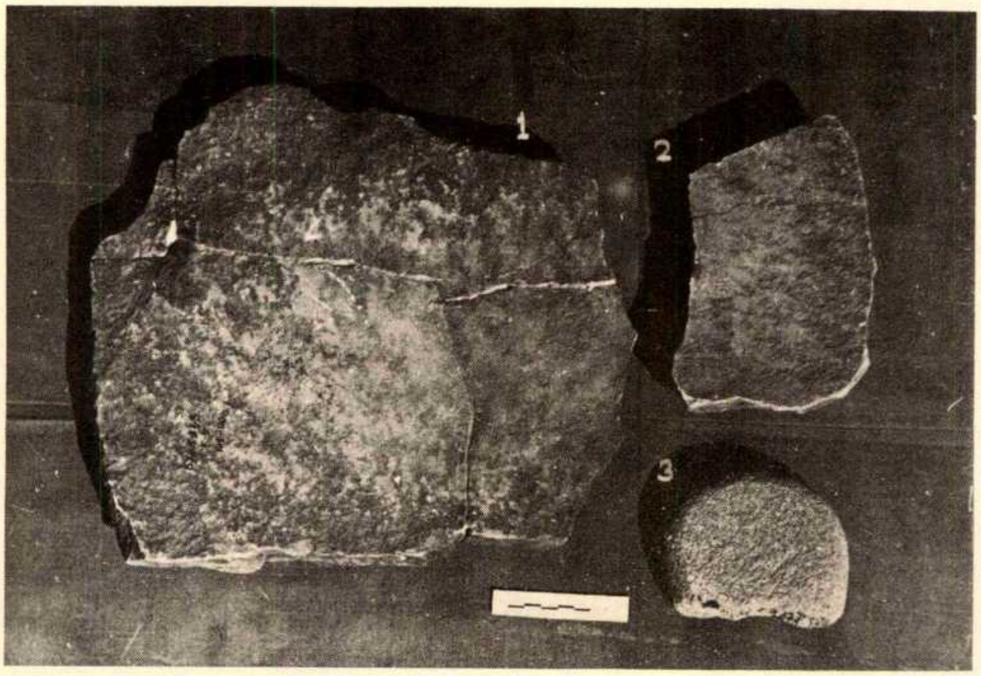

Fig. 38: Grinding stones of Mesolithic period from Bhimbetka

Appendix I

Late Pleistocene Vertebrate Fossil Fauna of India (after Murty 1975; Badam 1984, 1989; Salahuddin 1987)

	River Valleys						Caves
Fossil Fauna	**Narmada**	**Son**	**Godavari**	**Ghod**	**Manjra**	**Mahanadi**	**Kurnool**
Primates							
Presbytis entellus	-	-	-	-	-	-	+
Papio sp.	-	-	-	-	-	-	+
Carnivora							
Panthera tigris	-	-	-	-	-	-	+
Panthera cf. *pardus*	-	-	-	-	-	-	+
Felis chaus	-	-	-	-	-	-	+
Felis rubiginosa	-	-	-	-	-	-	+
Crocuta crocuta	-	-	-	-	-	-	+
Viverra karnuliensis	-	-	-	-	-	-	+
Priondon sp.	-	-	-	-	-	-	+
Herpestes fuscus	-	-	-	-	-	-	+
Herpestes edwardsi	-	-	-	-	-	-	+
Melursus ursinus	-	-	-	-	-	-	+
Ursus sp.	+	-	-	-	-	-	-
Ursus namadicus	+	-	-	-	-	-	-
Canis sp.	-	-	-	+	-	-	-
Insectivora							
Sorex sp.	-	-	-	-	-	-	+
Chiroptera							
Taphozous saccolaimus	-	-	-	-	-	-	+
Hipposideros diadema	-	-	-	-	-	-	+
Rodentia							
Sciurus sp.	-	-	-	-	-	-	+
Tatera indica	-	-	-	-	-	-	+
Bandicota indica	-	-	-	-	-	-	+
Bandicota bengalensis	-	-	-	-	-	-	+
Mellardis mettada	-	-	-	-	-	-	+
Mus sp.	+	-	-	-	-	-	-
Mus platythrix	-	-	-	-	-	-	+
Golunda ellioti	-	-	-	-	-	-	+(?)
Hystrix sp.	+	-	-	-	-	-	-
Hystrix crassidens	+	-	-	-	-	-	+
Atherura karnuliensis	-	-	-	-	-	-	+
Lepus cf. *nigricollis*	-	-	-	-	-	-	+
Perissodactyla							
Equus namadicus	+	+	+	+	+	+	-
Equus asinus	-	+	-	-	-	-	+
Equus onager khur	+	-	-	-	-	-	-
Equus caballus	+	-	-	-	-	-	-

	River Valleys						Caves
Fossil Fauna	**Narmada**	**Son**	**Godavari**	**Ghod**	**Manjra**	**Mahanadi**	**Kurnool**
Rhinoceros sp.	+	+	-	-	-	-	-
Rhinoceros karnuliensis	-	-	-	-	-	-	+
Rhinoceros unicornis	+	-	-	-	-	-	-
Artiodactyla							
Bos sp.	+	-	+	+	-	+	-
Bos namadicus	+	+	-	+	+	+	-
Bos gaurus	+	+	-	-	-	-	-
Bos sp./ *Bubalus* sp.	-	-	-	-	-	-	+
Bubalus sp.	+	+	+	+	-	-	-
Bubalus bubalis	+	-	-	-	+	+	-
Bubalus palaeindicus	+	-	-	-	-	-	-
Leptobos sp.	-	-	-	+	-	-	-
Leptobos frazeri	+	-	-	-	-	-	-
Bibos sp.	+	-	-	-	-	-	-
Bison sp.	+	-	-	-	-	-	-
Hippopotamus sp.	+	+	-	+	+	-	-
Hippopotamus namadicus	+	-	-	-	-	-	-
Hippopotamus palaeindicus	+	-	-	-	-	-	-
Boselephas tragocamelus	-	+	-	-	-	-	+
Boslephas namadicus	+	-	-	-	-	-	-
Gazella gazella bannetti	+	+	-	-	-	-	+
Antilope cervicapra	+	+	-	-	+	-	+
Tetracerus quadricornis	-	+	-	-	-	-	+
Cervus unicolor	+	+	-	+	-	-	+
Cervus styloceros	+	-	-	-	-	-	-
Cervus duvauceli	+	+	-	-	-	-	-
Cervus affinis	+	-	-	-	-	-	-
Axis axis	+	+	-	-	+	-	+
Muntiacus muntjak	-	+	-	-	-	-	+(?)
Tragulus cf *memmina*	-	-	-	-	-	-	+
Sus sp.	+	+	-	+	+	-	-
Sus namdicus	+	-	-	-	-	-	-
Sus scrofa cristatus	+	-	-	-	-	-	+
Sus karnuliensis	-	-	-	-	-	-	+
Proboscidea							
Elephas maximus	-	-	+	-	+	-	-
Elephas namadicus	+	-	+	-	-	-	-
Elephas hysudricus	+	-	-	-	+	-	-
Elephas sp.	+	+	-	+	-	-	-
Stegodon insignis ganesa	+	-	-	-	+	-	-
Pholidota							
Smutsia gigantea	-	-	-	-	-	-	+

	River Valleys						Caves
Fossil Fauna	**Narmada**	**Son**	**Godavari**	**Ghod**	**Manjra**	**Mahanadi**	**Kurnool**
Reptilia							
Crocodylus sp.	+	-	-	-	+	-	+
Chelonia sp.	-	-	-	-	+	-	-
Gavialis sp.	+	+	-	-	-	-	-
Trionyx sp.	+	+	-	-	-	-	-
Emys namadicus	+	-	-	-	-	-	-
Emys sp.	+	+	-	-	-	-	-
Pengsura tectum	+	-	-	-	-	-	-
Lessemys sp.	+	-	-	-	-	-	-
Varanus dracaena	-	-	-	-	-	-	+
Python molurus	-	-	-	-	-	-	+
Ptyas mucosus	-	-	-	-	-	-	+

Appendix II

Vertebrate Fauna from Mesolithic Sites

(After Clutton-Brock 1965; Thomas 1975; G.R. Sharma 1973b; Sharma *et al.* 1983; Misra 1988)

Fauna	Langhnaj	Tilwara	Bagor	Adamgarh	Sarai Nahar Rai	Chopani Mando	Mahadaha	Bhimbetka
DOMESTIC								
Perissodactyla								
Equus caballus (Horse)	-	+	-	+	-	-	+	-
Artiodactyla								
Bos indicus (Cattle)	-	+	+	+	+	+	+	+
Bubalus bubalis (Buffalo)	-	-	+	+	+	-	-	-
Ovis aries (Sheep)	-	-	+	+	+	+	+	-
Capra hircus hircus (Goat)	-	+	+	+	+	+	+	-
Sus scrofa cristatus (Pig)	-	+	+	+	-	-	-	-
Proboscidea								
Elephas maximus (Elephant)	-	-	-	-	+	-	-	-
WILD								
Carnivora								
Canis lupus (Wolf)	+	-	-	-	-	-	-	-
Vulpes bengalensis (Fox)	-	-	+	-	-	-	-	-
Herpestes edwardsi (Mongoose)	+	+	+	-	-	-	-	-
Perissodactyla								
Rhinoceros unicornis (Rhinoceros)	+	-	-	-	-	-	-	+
Artiodactyla								
Sus scrofa (Boar)	+	-	-	-	-	-	-	-
Boselaphus tragocamelus (Nilgai)	+	-	+	-	-	-	-	-
Antilope cervicapra (Blackbuck)	-	-	+	-	-	-	-	-
Gazella dorcas (Chinkara)	-	-	+	-	-	-	-	-

Fauna	Langhnaj	Tilwara	Bagor	Adamgarh	Sarai Nahar Rai	Chopani Mando	Mahadaha	Bhimbetka
Cervus duvauceli (Barasingha)	+	-	-	-	-	-	-	-
Cervus unicolor (Sambar)	+	-	-	-	-	-	-	+
Axis axis (Chital)	+	+	+	+	-	-	-	+
Axis porcinus (Hog deer)	+	+	-	-	-	-	-	-
Rodentia								
Lepus nigricollis (Hare)	-	-	+	+	-	-	+	-
Funambulus sp. (Squirrel)	+	-	-	+	-	-	-	-
Reptilia								
Tortise	+	-	-	-	+	-	+	-
Varanus flavescens (Yellow monitor)	-	-	-	+	-	-	-	-
Fish	+	-	-	-	-	-	+	-
Bird	-	-	-	-	-	-	+	-

Appendix III

Radiometric Dates from Stone Age Sites

I. Radiocarbon Dates (After Possehl 1988; Misra and Rajaguru 1986)

Middle Palaeolithic

Site Name	Lab No	5568 BP	5730 BC	Calibration	Date List
Badalpur	PRL 88	24300 ± 1700	23079 ± 1750	N.A.	
Bardia Hill	TF 764A	16485 ± 445	15030 ± 460	N.A.	-
Bardia Hill	TF 764B	11420 ± 190	9813 ± 195	N.A.	-
Bhimbetka	PRL 787	15370 ± 570	13880 ± 587	N.A.	PRL V
Bhimbetka	PRL 788	17230 ± 480	15795 ± 494	N.A.	PRL V
Bhimbetka	PRL 789	17670 ± 490	16250 ± 505	N.A.	PRL V
Dhamner	PRL 143	10130 ± 250	8484 ± 260	N.A.	PRL II
Dhom Dam	TF 1004	37640 ± 9200	36819 ± 9475	N.A.	-
Gerwa Well	PRL 710	26090 ± 800	24925 ± 824	N.A.	PRL V
Mula Dam	TF 217	> 39000	> 38220	N.A.	
Mula Dam	TF 345	31075 ± 5550	30057 ± 5710	N.A.	
Nandipalli	PRL 293	23670 ± 640	22430 ± 650	N.A.	
Nandur Madhmeshwar	BS 163	26600 ± 430	25450 ± 443	N.A.	BS III
Nirgudsar	PRL 609	> 31000		N.A.	PRL V
Rati Karar	TF 967	32750 ± 1770	31783 ± 1825	N.A.	-
Prabhas Patan	PRL 30	20825 ± 670	19500 ± 690	N.A.	PRL III
		Upper Palaeolithic			
Asla	TF 1178	9740 ± 125	8082 ± 130	N.A.	TATA X
Baghor	BETA 4793	25485 ± 420	24300 ± 430	N.A.	-
Baghor	PRL 711	12450 ± 220	10875 ± 227	N.A.	PRL V
Baghor	BETA 4792	11525 ± 120	9921 ± 125	N.A.	
Baghor	SUA 1420	10415 ± 140	8777 ± 145	N.A.	-
Baghor III	PRL 714	6460 + 180	4705 + 185	5565 B.C.- 5205 B.C.	PRL V
Didwana (16R)	PRL 911	26210 ± 2200 - 1700			
Ghargaon	TF 1111	10020 ± 150	8371 ± 155	N.A.	TATA X
Mahagara	PRL 86	25707 ± 810	24528 ± 835	N.A.	PRL II
Mahagara	TF 1245	19160 ± 330	17785 ± 340	N.A.	TATA XI
Mahagara	PRL 603	13740 ± 400	12200 ± 412	N.A.	PRL V
Mahagara	BS 130	11550 ± 180	9945 ± 185	N.A.	BS III
Mahagara	PRL 602	10980 ± 190	9360 ± 196	N.A.	PRL V
Patne	GRN 7200	24270 ± 195	23048 ± 200	N.A.	-
Sangamner	BS 78	24670 ± 710	23460 ± 731	N.A.	BS II
Sangamner	PRL 470	14400 ± 340	12880 ± 350	N.A.	PRL IV

Site Name	Lab No	5568 BP	5730 BC	Calibration	Date List
		Mesolithic			
Adamgarh	TF 120	7240 ± 125	5505 ± 129	N.A.	TATA V
Adamgarh	TF 116	2765 ± 105	900 ± 108	1105 B.C.- 805 B.C.	TATA V
Baghai Khor	TF 187	270 ± 120	1670 ± 124 A.D.	N.A.	
Baghor	SUA 1422	5305 ± 90	3514 ± 90	4110 B.C- 3795 B.C.	
Baghor II	PRL 715	8090 ± 220	6385 ± 227	N.A.	PRL V
Bagor	TF 786	6245 ± 200	4480 ± 206	5365 B.C.- 4965 B.C.	TATA IX
Bagor	TF 1007	5620 ± 125	3840 ± 129	4570 B.C.- 4385 B.C.	TATA VIII
Bagor	TF 1011/2	5090 ± 85	3295 ± 88	3955 B.C.- 3775 B.C.	TATA IX
Bagor	TF 1009	4585 ±105	1775 ± 108	3400 B.C.- 3160 B.C.	TATA IX
Bagor	TF 1005/6	3945 ± 90	2115 ± 93	2650 B.C.- 2315 B.C.	TATA IX
Bhimbetka	PRL 17	7570 ± 210,	5845 ± 216	N.A.	PRL I
Bhimbetka	PRL 50	5860 ± 110	4085 ± 113	4950 B.C.- 4560 B.C.	PRL I
Bhimbetka	PRL 318	3560 ± 100	1715 ± 103	2135 B.C.- 1755 B.C.	PRL III
Bhimbetka	PRL 306	2820 ± 110	955 ± 113	1125 B.C.- 825 B.C.	PRL III
Bhimbetka	PRL 534	2780 ± 150	915 ± 155	1125 B.C.- 795 B.C.	PRL V
Bhimbetka	PRL 18	2650 ± 125	780 ± 129	890 B.C.- 770 B.C.	PRL I
Bhimbetka	PRL 317	2490 ± 100	615 ± 103	795 B.C.- 420 B.C.	PRL III
Bhimbetka	PRL 310	2320 ± 100	440 ± 103	445 B.C.- 375 B.C.	PRL III
Bhimbetka	PRL 51	2050 ± 110	160 ± 113	185 B.C.- 35 A.D.	PRL I
Bhimbetka	PRL 316	1930 ± 100	40 ± 103	35 B.C.- 95 A.D.	PRL III
Bhimbetka	PRL 315	1760 ± 180	135 ± 185	10 A.D.- 465 A.D.	PRL III
Bhimbetka	PRL 535	1160 ± 150	755 ± 155	790 A.D.- 1175 A.D.	PRL V
Bhimbetka	PRL 311	1060 ± 80	860 ± 82	870 A.D.- 1050 A.D.	PRL III
Inamgaon	BS 146	11700 ± 150	10100 ± 155	N.A.	BS III
Langhnaj	TF 744	3875 ± 105	2040 ± 108	2550 B.C.- 2185 B.C.	TATA VI

Site Name	Lab No	5568 BP	5730 BC	Calibration	Date List
Lekhahia	TF 419	4240 ± 110	2415 ± 113	3035 B.C.- 2780 B.C.	TATA VI
Nirgudsar	BS 43	39000 ± 3200	38220 ± 3296	N.A.	BS III
Sarai Nahar Rai	TF 1356/59	2860 ± 120	995 ± 124	1140 B.C.- 865 B.C.	TATA XI
Sarai Nahar Rai	TF 1104	10050 ± 110	8400 ± 113	N.A.	TATA X

Thermoluminescence Dates

(After Misra and Rajaguru 1986; Singhvi *et al.* 1982; Rendell *et al* 1987; Misra *et al.* 1988)

Middle Palaeolithic

Didwana (16R)	Alpha Lab No. 963	163000 ± 21000 B.P.

Upper Palaeolithic

Riwat (Pakistan)		>420000 B.P.

Mosolithic

Amarpura	PRL:TL:S9	6140 B.P.
Amarpura	PRL:TL:S8	14610 B.P.
Amarpura	PRL:TL:S7	16190 B.P.
Langhnaj	PRL:TL:S12	5180 B.P.
Langhnaj	PRL:TL:S11	8630 B.P.
Langhnaj	PRL:TL:S10	20280 B.P.
Bagor	PRL:TL:S13	2100 B.P.
Bagor	PRL:TL:S14	3420 B.P.

U/Th Dates

(After Baskaran *et al.* 1986; Raghavan *et al.* 1989)

Lower Palaeolithic

Didwana (16R)	150000 B.P.
Junagadh	69000 B.P.
Umrethi	190000 B.P.

Midlle Palaeolithic

Didwana (16R)	166000 B.P.
Jetpur	>56000 B.P.

Pre-Iron Age Agricultural Settlements in South India: An Ecological Perspective

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Introduction

The earliest agricultural settlements in South India date back to the third millennium B.C. when they make a rather sudden appearance in the lower Godavari, Krishna, Tungabhadra, Penneru and Kaveri basins encompassing the states of Andhra Pradesh, Karnataka and Tamil Nadu. These sites, by and large, are scattered in the semi-arid, low rainfall, and sandy loamy regions which are of marginal utility for farming and better suited for pastoralism. The salient features of these agricultural settlements are: (1)sedentary village settlements with semi-permanent to permanent structures (mostly wattle and daub); (2)stone tools fashioned by grinding and polishing (hence, referred to as the polished stone axe industry) made on hard rocks like dolerite and basalt; (3)long and thin blade artifacts made on fine grained rocks like chert, jasper, chalcedony and agate; (4)pottery which is handmade in the earlier stages and wheelmade in the later stages; and (5)an economy based on millet farming, and cattle and sheep/goat pastoralism, notwithstanding the fact that the dietary requirements are supplemented by wild game. The economy is thus basically agro-pastoral with a sedentary village life. By a synthesis of the overall evidence Bridget and Raymond Allchin (1968, 1982) distinguished three broad phases in the growth of these settlements in South India.

Phase I : This represents the earliest settlements on tops of granitoid hills, or on levelled terraces on hillsides, or in the valleys between two or more hills. The material culture consists of a polished stone axe industry, a blade and bladelet tool techno-complex, and handmade pottery. In pottery grey or buff-brown ware is most common, and a ware which is less common has a black or red burnished slip, often with purple painted decorations. The excavated ashmound sites of Utnur (Allchin 1961), Kupgal (Foote 1887; Majumdar and Rajaguru 1966), Kodekal (Paddayya 1973), Palvoy (Rami Reddy 1976); and the lower Neolithic levels at Piklihal (Allchin 1960), Maski I (Thapar 1957) and Brahmagiri IA (Wheeler 1947-48) are regarded as typical of these earliest occupations.

It has been suggested that the ashmounds or cattle-pens (Allchin 1963) are places where cattle (*Bos indicus*) were herded, and that cattle husbandry played a major role in the economy. To stress the later aspect, the terracotta figurines of humped cattle recovered from Piklihal and the rock-paintings and bruisings of cattle around the settlements at Kupgal, Maski and Piklihal are taken as evidence. Nevertheless, the rubbing stones and querns found in these earliest levels provide indirect evidence for the processing of grain foods.

An important feature of the pottery (grey ware) of this phase was the use of bands of red ochre applied after firing. Other noteworthy features are the applied ring feet and hollow pedestals, recalling those of pre-Harappan Amri or Kalibangan.

Following Bridget and Raymond Allchin (1968: 163) and considering the radiocarbon dates, these earliest levels of habitation may be ascribed to c. 2500-1800 B.C.

Phase II : The settlement pattern continues without any change in that, settlements were still made on top of granite hills or on levelled terraces on the hillsides. But important developments can be seen in the structures: circular hutments of wattle and daub on wooden frames with mud floors. New elements in pottery—especially perforated and spouted vessels—which appear in this phase reveal contacts with regions in the north. So also is the technique of roughening the outer surface of pottery, reminiscent of that employed in the Indus valley and Baluchistan in the early Harappan levels.

The polished stone axe industry and the stone blade industry proliferates. A small number of copper and bronze objects appear for the first time and increase in frequency towards the end of this phase. A gold ornament is reported from Tekkalakota I. The occupations at Piklihal (Upper Neolithic), Brahmagiri (Parts IA and IB), Sanganakallu I.1 (Subbarao 1948; Ansari and Nagaraja Rao 1969), Tekkalakota I (Nagaraja Rao and Malhotra 1965), Hallur IIA

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(layers 10-11) (Nagaraja Rao 1971) and T. Narasipur (Seshadri 1971) belong to this phase.

The settlements at Hallur I (layers 10-11) and T. Narasipur appear to begin from this phase and represent a southern but slightly later extension of Phase I (Allchin and Allchin 1968: 163). On the basis of a few radiocarbon dates they suggest that this phase falls between c. 1800 and 1500 B.C.

Phase III: This phase is recognised by the increase in the number of tools of copper and bronze. Such an increase is recorded at Tekkalakota II, Hallur (layers 8-9), Piklihal (intrusion), Sanganakallu I.2 and Brahmagiri. Occupation horizons of this phase seem to be present at Paiyampalli (*IAR* 1964-65). The stone axe and blade industries continue. In the ceramics a new grey and buff ware, with a harder surfaced, becomes common. Ths is also the case with an entirely new wheel-thrown unburnished ware with purple paint, and this has affinities to the Chalcolithic Jorwe ware of Maharashtra. On these grounds a time bracket of c. 1400-1050 B.C. has been suggested for Phase III (Allchin and Allchin 1968: 165). At the beginning of this phase, at Hallur, a horse(?) (*Equus caballus*) bone was found and according to Bridget and Raymond Allchin (1968: 153, 165) this has some significance seen in the context of an extensive group of rock paintings showing horses and riders, as well as in the discovery of swords or dirks of copper or bronze with midribs and antennae hilts found at Kallur in the Raichur district (Karnataka). These Kallur bronze objects recall one of the several types of copper/bronze objects found in parts of Uttar Pradesh and the northwestern region of the Indian subcontinent, some of which are recorded in the Chalcolithic levels of the northern Deccan and Central India. As these copper/bronze objects display similarities to those of Iran (datable to the middle of the second millennium B.C.) Allchin and Allchin suggest that these (stray) finds appear to be consistent with the movement of people from the direction of Iran. In so far as South India is concerned, several similarities in the material culture and burial customs point to close cultural contacts with Maharashtra during Phase III which is foreshadowed in Phase II.

This three phase sequence of Bridget and Raymond Allchin can be treated as a generalized framework for the emergence and expansion of early farming and pastoral settlements in South India. The select list of radiocarbon dates given in Table 1 indicates the chronological range. An important feature of the occupation levels at some settlements grouped under Phase I (Utnur, lower Neolithic of Piklihal, Maski I, parts of Brahmagiri IA) is the absence of copper or bronze objects. In the context of the continuity of occupation from Phase I to III at some of the excavated sites, and with no drastic change in the economy, the occupation of Phases II to III (labelled as Neolithic-Chalcolithic) can be considered as metal-using Neolithic cultures.

In addition to the excavated sites which formed basis for this threefold sequence, there are numerous sites in Telangana, Rayalaseema, coastal Andhra Pradesh, north Maidan of Karnataka, Tamil Nadu highlands and the Sahyadris of Tamil Nadu (for bibliography and some details see Foote 1887, 1916; Sarma 1967; Hanumantha Rao and Nagaraju 1974; Subrahmanyam et al. 1975; Narasimhaiah 1980; Ramachandran 1980; Krishna Sastry 1983; David Raju 1985; Sundara 1985; annual numbers of *Indian Archaeology - A Review*) some of which are taken into account (Table 2) for an ecological perspective.

Landscape Ecology and Farming Practices

The epicentres of these settlements are favourable resource zones for agro-pastoral economies. As can be seen from the general pattern of settlements in the respective physiographic zones (see Table 2), the preferred landforms are low hilly ranges away from major watersheds but in proximity to streams; soil zones which are tropical black clays, tropical red and black sandy loams, sandy or sandy-loamy ferruginous tropical soils, and deltaic alluvium. The annual average rainfall is in the range of 600-1200 mm and the floristic cover is characterised by scrub woodland, savanna woodland, scattered shrubby facies and thorny thickets of different vegetational series (Fig. 1). These sites are more commonly dispersed in the castellated hills, and the habitations are usually at the foot of the hills or on the tops of hills.

Considering the settlement pattern in relation to landscape ecology, it becomes obvious that areas which were suited largely for rainfed gravity-flow irrigation were essentially colonised. Nonetheless, there are some sites like Veerapuram on the bank of the Krishna (Sastry *et al.* 1984), Hallur on the Tungabhadra, T. Narasipur at the confluence of the Kaveri and Kabbani, and those in the deltaic alluvium of the Krishna, where there is scope for water management through canal irrigation. However, one must await the evidence from extensive horizontal excavations, as at Inamgaon (Dhavalikar *et al.* 1988). The available archaeological evidence which, though meagre, indicates that millet and pulses were the main cultivated crops (Allchin 1969; Kajale 1974). The known evidence points to the cultivation of finger millet (*Eleusine coracana*) recorded at Paiyampalli and at Hallur, (though its identification at the latter site has been questioned) (Kajale 1989:124); kodo millet (*Paspalum scrobiculatum*) identified at Hallur; leguminous plants such as horse gram (*Dolichos biflorus*) identified at Tekkalakota and Paiyampalli; and green gram (*Vigna radiata*) identified at Paiyampalli. Recently, Kajale (pers. comm.) has identified barley (*Hordeum vulgare*), black gram (*Phaseolus mungo*) and hyacinth bean (*Dolichos lablab*) at Ramapuram, and rice (*Oryza sativa*), black gram (*Vigna mungo*), green gram and hyacinth bean at Hallur (Kajale 1989). The remains of these millets and grams and the location of these sites, seen in the context of the prevailing agricultural practices suggest that the prehistoric crop

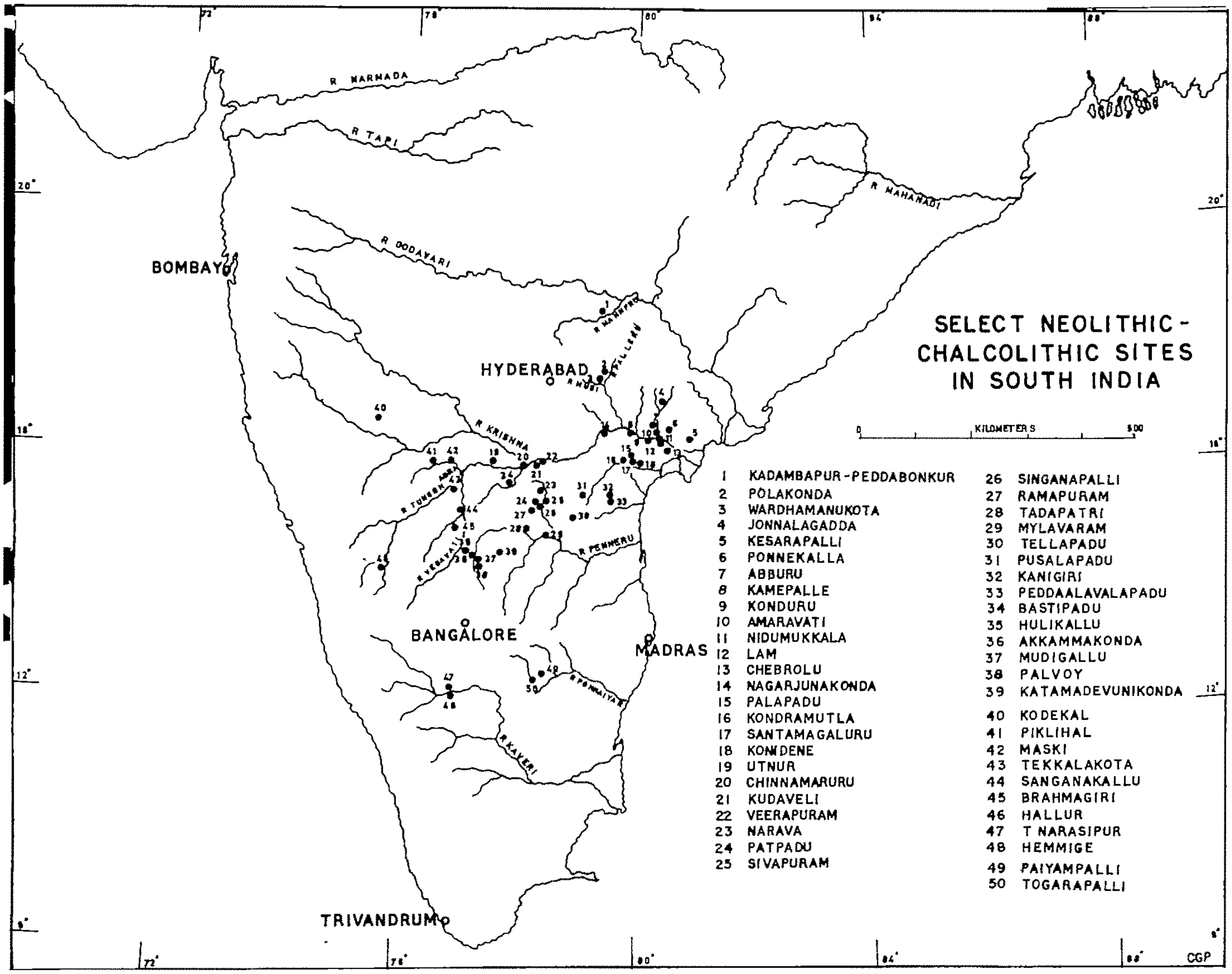

Fig 1: Select Neolithic-Chalcolithic Sites in South India

management pattern could not have been much different from that of today. To argue in favour of such a viewpoint, we can take into account a microregion, e.g. Betamcherla (Kurnool district, Andhra Pradesh) which falls within the environmental zone of Ramapuram site. This is a low hilly country of the Erramalais (a chain of the Eastern Ghats), with an average annual rainfall of less than 600 mm and drained by a seasonal stream. The *kharif* crop is a major crop in this region and it depends purely on monsoonal rainfall (June to November). The cropping pattern is that of sole cropping and mixed cropping, the latter varying from year to year and to some extent from field to field. The cultivated crops are red foxtail millet (*Setaria italica*), "plaited" foxtail millet (*Setaria italica*), three kinds of sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum amcucanum*), pigeon pea (*Cajanus cajan*), horse gram (*Macrotyloma muniflorum*), hyacinth bean (*Lablab purpureus*), green gram (*Vigna radiata*), cow pea (*Vigna unguiculata*), seasame (*Sesamum indicum*), castor (*Ricinus communis*) and three types of cotton (*Gossypium arboreum, Gossypium hirsutum*). Rice (*Oryza sativa*) is also grown in the valleys where there is scope for canal irrigation. Remains of all these crops are not recorded in the prehistoric agricultural settlements of South India. Most of them, however, do occur though not together at any one site, in the Chalcolithic to early Historic settlements of the Deccan which fall in the semi-arid zone (Kajale 1974). In view of the variety of the cereals, pulses, oil crops and fibre crops which are presently cultivated in different parts of the Deccan, it may not be unreasonable to predict that a mixed cropping system consisting of several of the above could have prevailed in the prehistoric agricultural pattern in South India. Such an inference remains only speculative until substantiated by archaeobotanical evidence. Unfortunately, in the archaeological context, more often than not, it is only the carbonised grains which are preserved. If the observations on grain preservation around grain storage places are any guide, one should expect that none of the uncarbonised grains would have escaped destruction by storage pests. As we know today, pulses are destroyed by the pulse beetle (*Callaso bruchus chinensis*). All other pulses and cereals are completely destroyed by the lesser grain borer (*Rhizopertha dominica*), rice weevils (*Sitophylus oryzae and Sitophylus granarium*), the rice moth (*Corcifera cephalonica*) and flour beetles (*Tribolium castaneum and Tribolium confusum*). Proceeding on the premise that rainfed gravity flow irrigation and the mixed cropping system on level terraces of hills and foothills was the land use pattern during this early agricultural period, it would be worthwhile to consider the large number of surficial sites (findspots rather) which have yielded only the polished stone axes. Several of the sites listed in Table 2 are of this category. The dispersal of polished stone axes in the hilly areas with a varied floristic cover and with no trace of habitational debris first of all indicates that the place of their discard represents certain activity loci. In view of the functional attributes of these artifacts they can be associated with tree felling and land clearance, and possibly woodwork. These surficial findspots seen in their locational context point out landscape manipulation of hilly and forested areas to make farmlands for dry farming, not very different from the present day practices in these areas. The occurrence of a large number of polished axes at high altitudes on several hill tops in Tamil Nadu (Shevroy, Javadi, Vattalamalai etc.) may possibly suggest shifting cultivation. The prevalence of shifting cultivation in the southern Western Ghats was reported in the last century (Cluckhorn 1861).

Livestock Management : Cattle Pastoralism

Almost all the excavated Neolithic-Chalcolithic sites in this region have yielded faunal remains which belong to both domesticated and wild species. The domesticated species, which vary from site to site, include cattle (*Bos indicus*), buffalo (*Bubalus bubalis*), sheep (*Ovis aries*), goat (*Capra hircus aegagrus*), pig (*Sus scrofa cristatus*), dog (*Canis familiaris*) and fowl (*Gallus* sp.) (Thomas 1974).

Among all the domesticated species cattle predominate at the majority of sites indicating a greater reliance on cattle management in the economy of these communities. For instance, in the Neolithic level at Veerapuram, where the faunal remains were subjected to meticulous scrutiny (Thomas 1984), cattle represent 48.68% whereas sheep/goat form only 5.4%. If such was the case at Veerapuram situated right on the bank of the Krishna with the potential for irrigation agriculture, then in the scores of sites located in the uplands, one should expect cattle pastoralism to have played a significant role in these early agricultural settlements. Cattle pastoralism linked to sedentary millet farming villages is the chief economic activity during the present times in the uplands of Telangana, Rayalaseema and north Maidan. What is important, is that the cattle of these villages, especially in certain areas of Rayalaseema are kept not in the village homesteads, but large herds of them are maintained in forest cattle stations. Allchin (1963) evaluating the Neolithic ashmounds of Andhra-Karnataka has argued that this practice dates back to Neolithic times. He has suggested that the ashmounds were the result of the ritual burning of cow dung accumulations in the cowpens by the Neolithic communities. The fact that some of the ashmounds (among the 70 and odd known), as pointed out by Foote (1916) must also have resulted due to autocombustion during periods of high summer temperatures cannot be ruled out. To return to the ritual burning aspect, we have an interesting example in the annual cattle festival of South India that coincides with *makara sankranti* (middle of January). On the third day of *sankranti* which is called *kanuma panduga* (*Telugu: kanuma*, ghat; *panduga*, festival) or *pasuvula panduga* (*pasuvu*, cattle), cattle of the respective villages, adorned with flowers and polychrome colours are taken into the forest beyond the ghat. In the forest, oblations (*pongali*: rice and grams cooked in milk and jaggery; and animal sacrifices) are offered to *katamayya*, the god of the forest, and a big bonfire is made at the place of worship. This bonfire, called *citla kuppa*, is made by the heaping up of dried scrub into which are thrown discarded agricultural implements (winnowing fans, brooms etc.) and dried cowdung. The cattle are taken in perambulation around the bonfire, the water used in the worship of *katamayya* is sprinkled on the cattle and the cattle are taken back to their respective homesteads. This *kanuma panduga* seen in its symbolic form gives an insight into understanding the importance bestowed on cattle in the agro-pastoral economies and also, perhaps, one of the possible associations of ashmounds with ritual bonfires. The god *katamayya* is propitiated for the wellbeing of cattle. The Neolithic site bearing the name Katamadevunikonda (the hill of god *katamayya*), situated at the headwaters of a small seasonal stream of the Penneru in the Anantapur district, Andhra Pradesh, is one example suggestive of the emergence of a cattle cult in the ideological realm of the agro-pastoral communities in this region.

Sheep/Goat Pastoralism

The remains of sheep/goat in almost all the Neolithic-Chalcolithic sites in South India are poorly represented. A possible explanation can be suggested for this. Aside from the obvious interpretation that they did not play an important role in the village economies, we may consider the ethnoecological criteria to evaluate whether or not sheep/goat pastoralism was an important adaptive strategy in the prehistoric past, as it is today. A greater part of this semi-arid country dotted with the early agricultural settlements, and having extensive grasslands forms the habitat of sheep/goat pastoralists—the *kuruvas* and *gollas* of Andhra Pradesh, the *kurubas* of Karnataka and the *dhangars* of Maharashtra. We may briefly make an apraisal of their oral traditions (Murty and Sontheimer 1980) without going deep into their mythologies, for this aspect. The sheep pastoral communities of Andhra - Karnataka claim their origin from an ancestral agricultural stock. Their god, before his deification, happened to be the youngest of the seven sons of an agricultural family which moved into this region from elsewhere. Owing to jealousies in the family this youngest son is driven out, is asked to move into a forested zone, and cultivate. While clearing the land for cultivation, he discovers sheep in a termite mound, becomes a shepherd, and spends twelve years in the forest moving from pasture to pasture. In all the oral traditions of the shepherds of Andhra, Karnataka and Maharashtra this is the root paradigm which explains the origin of the sheep pastoral groups. The present day shepherds of the Deccan are the progeny of this last son, and he is their god. From this incident portrayed in the legend it appears that sheep pastoralism branched off as a distinctive economic strategy from an agro-pastoral (predominantly millet farming and cattle herding) economic system. The sheep pastoralists believe that their original tradition was the same as that of the agriculturists, and the latter consider the former as the illegitimate children born to a concubine of their god in the forest. These two beliefs preserved in their mnemonic oral traditions also strengthen the hypothesis that sheep pastoralism, in the semi-arid landscape of the Deccan, originated as an offshoot of the sedentary village farming economies. The beginning of such a process of fissioning of sheep pastoral system may be ascribed to a period later than the third millennium B.C., after the colonisation of the semi-arid zones of Deccan by the Neolithic-Chalcolithic communities. If we fail to take cognizance of these oral traditions, cults and rituals as important ethnohistorical sources to complement the linkages, otherwise not preserved archaeologically, our interpretation of the evolution of cultural systems in this region would be incomplete and lopsided.

Hunter-Gatherer — Agro-Pastoral Interactions: The Process of Acculturation

Excavations being conducted in the cave areas of Kurnool (Murty 1985) have yielded evidence to show that the Mesolithic hunter-gatherers were inhabiting these areas when inroads were made by the early farming communities. The induction of an agro-pastoral way of life into the hitherto hunter-gatherer habitats resulted in the creation of new cultural ecosystems. The exploitative range of agro-pastoral communities is not confined merely to the vicinity of village settlements, but extended into the forested zones, for the maintenance of cattle in hill pastures, and dry farming operations. As a consequence, the hunter-gatherers were gradually drawn into the ambit of village cultures. Evidence in the form of pottery, and a few copper objects in the late Mesolithic levels of the Kurnool caves is proof enough to indicate cultural interactions between the late Mesolithic groups and the newly emergent agricultural settlements. These items, in all probability, were obtained in exchange by the former from thelatter as status symbols.

In this context it would be interesting to examine the occurrence of wild fauna in these early agricultural settlements. Important wild game represented are porcupine (*Hystrix indica*), black naped hare (*Lepus* cf. *nigricollis*), nilgai (*Boselaphus tragocamelus*), chinkara (*Gazella gazella bennetti*), blackbuck (*Antelope cervicapra*), sambar (*Cervus unicolor*) and chital (*Axis axis*) (Thomas 1974). This evidence if interpreted in a purely archaeological context leads to the conclusion that the village based communities were dependent as much on hunting as on farming and cattle pastoralism. Today all the peasants and pastoralists in these areas obtain meat foods of wild game and other forest produce by barter or cash purchase from the traditional hunter-gatherers. If the present is any guide, one can argue that the early agricultural communities may not have resorted to hunting as an important subsistence strategy but procured these meat foods from the late Mesolithic groups. The same reasoning can be extended to explain the occurrence of a few remains of domestic pig at Ramapuram and some other Chalcolithic sites in this region. Today none of the peasants and pastoralists in these areas maintain pigs, and those who are fond of pork obtain it from the traditional hunter-gatherers who have specialised in various pursuits (e.g. like the *Yerukulas* in the Kurnool area). It is thus possible that the consequences of the introduction of the village system into these areas: demographic increase, infringement into the hilly and forested terrain by the pastoralists with their livestock, and manipulation of the landscape for farming, at least partly disrupted the ecological balance of the late Mesolithic hunter-gatherers and induced a rescheduling of adaptive strategies (Murty 1985). The culture contact between late Mesolithic groups and the early farming communities must have initiated *proto-cooperation* to begin with, ultimately resulting in splitting the hunter-gatherers into different kinds of specialized professionals as enclaves in the village economy.

From early Medieval times onwards we have inscriptional sources to show that the state level societies expanded the king's domain into the forest and incorporated the forest ethnics, i.e. the traditional hunter-gatherers (who were given the appelation *kirata, pulinda, nishada, andh,* etc.) politically, by drafting them into the armies, administration and by conferring on them official ranks, as well as ritually, by patronising their deities.

Summary

The pre-Iron Age settlements in South India came into existence by about the third millennium B.C. in the lower Godavari, Krishna, Penneru, Tungabhadra and Kaveri river systems. Three broad phases in the evolution of these cultures are discerned. The earliest (Phase I), at some of the excavated sites have no metal (copper/bronze) whereas those of the later (Phases II and III) are marked by the increasing use of metal and interaction with the Chalcolithic cultures of the northern Deccan and Central India. There is a continuity in occupation and economic orientation from Phase I to Phase III and the settlement pattern in all the micro-regions is uniform. Settlements along the low hilly ranges are close to streams and away from major watersheds. The archaeobotanical and archaeozoological evidence seen in conjunction with the landscape ecology (topographical situation, soils, rainfall and floristic cover) of the micro-regions points out to an economy geared to gravity flow irrigation agriculture of millets and pulses and animal husbandry — prdominantly cattle, and sheep/goat to a lesser extent. On the basis of ethnohistories of this region it is suggested here that sheep/goat pastoralism branched off as a distinctive economic strategy from an ancestral millet farming-cum-pastoral stock. Such a fissioning should have occurred in later times since the colonisation of these river systems by the early agro-pastoral settlers. Another noteworthy feature of these early farming cultures is the interaction between them and the then surviving late Mesolithic cultures into whose habitats they moved.

The Neolithic-Chalcolithic cultural horizons at some sites overlap with the Iron Age, the beginnings of which can be ascribed to c. 1100 B.C. on the basis of a few radiocarbon dates. The terminal phase of Iron Age appears to date to c. 300 B.C. as script, coinage and growth of urban centres becomes evident, although not uniform throughout the South.

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Table 1 : Select list of radiocarbon dates indicating the chronological range of Neolithic-Chalcolithic sites in South India (after Possehl 1988)

Name of Site	Lab. No.	5568 BP	5730 BC	Calibration
Phase I				
Ramapuram	PRL-762	3810 ± 110 BP	1975 ± 113 BC	2415 - 2135 BC
Utnur	BM-54	4120 ± 150 BP	2295 ± 155 BC	2920 - 2535 BC
Utnur	TF-167	3840 ± 110 BP	2555 ± 113 BC	2555 - 2285 BC
Utnur	TF-168	3875 ± 110 BP	2040 ± 113 BC	2550 - 2185 BC
Kodekal	TF-748	4285 ± 105 BP	2465 ± 108 BC	3150 - 2865 BC
Palvoy	TF-701	3805 ± 100 BP	1970 ± 103 BC	2415 - 2135 BC
Palvoy	TF-700	3390 ± 095 BP	1540 ± 098 BC	1180 - 1595 BC
Paiyampalli	TF-827	3570 ± 105 BP	1725 ± 108 BC	3145 - 1760 BC
Phase II				
Sangankallu	TF-354	3440 ± 100 BP	1595 ± 103 BC	1965 - 1670 BC
Sangankallu	TF-359	3400 ± 100 BP	1550 ± 103 BC	1885 - 1645 BC
Tekkalakota	TF-237	3465 ± 105 BP	1620 ± 108 BC	1965 - 1680 BC
Tekkalakota	TF-262	3460 ± 135 BP	1615 ± 139 BC	1990 - 1660 BC
Tekkalakota	TF-239	3395 ± 105 BP	1545 ± 108 BC	1885 - 1645 BC
Hallur	TF-580	3560 ± 105 BP	1715 ± 108 BC	2135 - 1755 BC
Hallur	TF-576	3280 ± 105 BP	1430 ± 108 BC	1720 - 1430 BC
T. Narasipur	TF-412	3645 ± 105 BP	1805 ± 108 BC	2195 - 1885 BC
T. Narasipur	TF-413	3345 ± 105 BP	1495 ± 108 BC	1785 - 1560 BC
Phase III				
Sangankallu	TF-355	3435 ± 100 BP	1540 ± 103 BC	1925 - 1670 BC
Hallur	TF-586	3055 ± 095 BP	1195 ± 098 BC	1445 - 1235 BC
Paiyampalli	TF-833	3215 ± 210 BP	1360 ± 216 BC	1750 - 1270 BC
Polakonda	BS-098	3255 ± 120 BP	1405 ± 124 BC	1700 - 1415 BC
Veerapuram	PRL-730	3150 ± 140 BP	1295 ± 144 BC	1670 - 1255 BC

Table 2 : Distribution pattern of Neolithic-Chalcolithic sites in South India in relation to physiography

Sr. No.	Name of Site	Physiographic Zone / Soil Type / River System	Altitude (m) Rainfall (mm)	Vegetation Type
Andhra Pradesh				
1	Budigapalli (Husnabad tk., Karimnagar dist.)	Telangana plateau; Tropical red loams; Stream of Manneru	300-450; 800-1000	Low open forest of *Anogessius-Terminalia-Tectona* series
2	Thogarrai (Peddapalli tk., Karimnagar dist.)	Telangana plateau; Tropical red loams; Stream of Godavari	150-300; 800-1000	Discontinuous thickets of *Anogessius-Terminaalia-Tectona* series
3	Kadambapur (Peddapalli tk., Karimnagar dist.)	Telangana plateau; Tropical red loams; Stream of Manneru	150-300; 800-1000	Discontinuous thickets of *Anogessius-Terminalia-Tectona* series
4	Peddabankur (Peddapalli tk., Karimnagar dist.)	Telangana plateau; Tropical red loams; Stream of Manneru	150-300; 800-1000	Discontinuous thickets of *Anogessius-Terminalia-Tectona* series
5	Polakonda (Jangaon tk., Warangal dist.)	Telangana plateau; Tropical red loams; Stream of Palleru	150-300; 1000	Scattered shrubby facies of *Anogessius-Terminalia-Tectona* series
6	Kolakonda (Jangaon tk., Warangal dist.)	Telangana plateau; Tropical red loams; Stream of Musi	300-450; 800-1000	Scattered shrubby facies of *Anogessius-Terminalia-Tectona* series
7	Deveruppula (Jangaon tk., Warangal dist.)	Telangana plateau; Tropical black clays; Stream of Musi	300-450; 800-1000	Scattered shrubby facies of *Anogessius-Terminalia-Tectona* series
8	Wardhamanukota (Suryapet tk., Nalgonda dist.)	Telangana plateau; Tropical red loams; Stream of Musi	150-300; 800-1000	Scattered shrubby facies of *Anogessius-Terminalia-Tectona* series
9	Nagarjunakonda (Gurjala tk., Guntur dist.)	Telangana plateau; Tropical black clays; Middle reaches of Krishna	150-300; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
10	Kokapet (Hyderabad West tk., Hyderabad dist.)	Telangana plateau; Tropical red sandy loams; River Musi	450-600; 800	Savanna woodland of *Hardwickia-Pterocarpus-Anogessius* series
11	Utnur (Makthal tk., Mahbubnagar dist.)	Telangana plateau; Tropical red sandy loams; Stream of Tungabhadra	300-450; 700-800	Open forest of *Hardwickia-Pterocarpus-Anogessius* series

Sr. No.	Name of Site	Physiographic Zone / Soil Type / River System	Altitude (m) Rainfall (mm)	Vegetation Type
12	Chinnamaruru (Kollapur tk., Mahbubnagar dist.)	Telangana plateau; Tropical black clays; Middle reaches of Krishna	150-300; 700-800	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
13	Kudaveli (Alampur tk., Mahbubnagar dist.)	Telangana plateau; Tropical black clays; Middle reaches of Krishna	150-300; 700-800	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
14	Karapakala (Alampur tk., Mahbubnagar dist.)	Telangana plateau; Tropical black clays; Middle reaches of Krishna	150-300; 700-800	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
15	Veerapuram (Nandikotkur tk., Kurnool dist.)	Telangana plateau; Tropical black clays; Middle reaches of Krishna	150-300; 700	Savanna woodland of *Hardwickia-Pterocarpus-Anogessius* series
16	Bastipadu (Kurnool tk., Kurnool dist.)	Rayalaseema plateau; Tropical red and black sandy loams; Stream of Hindri	300-450; 700	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* serie
17	Malapuram (Uravakonda tk., Anantapur dist.)	Rayalaseema plateau; Tropical red sandy soils; Stream of Hagari	300-450; 600	Pseudosteppe of *Albizzia amara-Acacia* series
18	Akkammakonda (Kalyandurg tk., Anantapur dist.)	Rayalaseema plateau; Tropical red sandy soils; Stream of Vedavati	450-600; 600	Discontinuous thorny thickets of *Albizzia-amara-Acacia* series
19	Itlampalle (Kalyandurg tk., Anantapur dist.)	Rayalaseema plateau; Tropical red sandy soils; Stream of Vedavati	450-600; 600	Discontinuous thorny thickets of *Albizzia amara-Acacia* series
20	Hulikallu (Kalyandurg tk., Anantapur dist.)	Rayalaseema plateau; Tropical red sandy soils; Stream of Vedavati	450-600; 600	Discontinuous thorny thickets of *Albizzia amara-Acacia* series
21	Mudigallu (Kalyandurg tk., Anantapur dist.)	Rayalaseema plateau; Tropical red sandy soils; Stream of Penneru	450-600; 600	Discontinuous thorny thickets of *Albizzia amara-Acacia* series
22	Yatakal North West (Kalyandurg tk., Anantapur dist.)	Rayalaseema plateau; Tropical red sandy soils; Stream of Penneru	450-600; 600	Discontinuous thorny thickets of *Albizzia amara-Acacia* series
23	Palavoy (Kalyandurg tk., Anantapur dist.)	Rayalaseema plateau; Tropical red sandy loams; Stream of Penneru	300-450; 600	Tropical thorn forest of *Albizzia amara-Acacia* series

Sr. No.	Name of Site	Physiographic Zone / Soil Type / River System	Altitude (m) Rainfall (mm)	Vegetation Type
24	Tadipatri (Tadipatri tk., Anantapur dist.)	Rayalaseema plateau; Tropical red sandy loams; River Penneru	150-300; 600	Discontinuous thorny thickets of *Hardwickia-Pterocarpus-Anogessius*
25	Katamadevunikonda (Anantapur tk., Anantapur dist.)	Rayalaseema plateau; Tropical red sandy loams; Stream of Penneru	300-450; 600	Discontinuous thorny thickets of *Albizzia amara-Acacia* series
26	Mushturu (Kadiri tk., Anantapur dist.)	Rayalaseema plateau; Tropical red sandy loams; Stream of Chitravati	300-450; 600	Discontinuous thorny thickets of *Albizzia amara-Acacia* series
27	Mylavaram (Jammalamadagu tk., Cuddapah dist.)	Rayalaseema plateau; Tropical black clays; River Penneru	150-300; 600	Discontinuous thickets of *Hardwickia-Pterocarpus-Anogessius* series
28	Kamepalle (Gurjala tk., Guntur dist.)	Central Eastern Ghats; Tropical black clays; Stream of Krishna	50-100; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
29	Kondramutla (Vinukonda tk., Guntur dist.)	Central Eastern Ghats; Tropical black clays; Stream of Kandaleru	100-150; 700	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
30	Kambampadu (Vinukonda tk., Guntur dist.)	Central Eastern Ghats; Tropical black clays; Stream of Kandleru	100-150; 700	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
31	Tellapadu (Vinukonda tk., Guntur dist.)	Central Eastern Ghats; Tropical black clays; Stream of Kandleru	100-150; 700	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
32	Uppalapadu (Giddalur tk., Prakasam dist.)	Southern Eastern Ghats; Loamy ferruginous tropical soils; River Sagileru	150-300; 700-800	Discontinuous thickets of *Hardwickia-Pterocarpus-Anogessius* series
33	Narava (Giddalur tk., Prakasam dist.)	Southern Eastern Ghats; Loamy ferruginous tropical soils; River Sagileru	150-300; 700-800	Discontinuous thickets of *Hardwickia-Pterocarpus-Anogessius* series
34	Pusalapadu (Giddalur tk., Prakasam dist.)	Southern Eastern Ghats; Loamy ferruginous tropical soils; River Sagileru	150-300; 700-800	Discontinuous thickets of *Hardwickia-Pterocarpus-Anogessius* series
35	Patpadu (Banaganapalle tk., Kurnool dist.)	Southern Eastern Ghats; Tropical red and black sandy loams; Stream of Kunderu	150-300; 600	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series

Sr. No.	Name of Site	Physiographic Zone / Soil Type / River System	Altitude (m) Rainfall (mm)	Vegetation Type
36	Ramapuram (Banaganapalle tk., Kurnool dist.)	Southern Eastern Ghats; Tropical black clays; Stream of Kunderu	300-450; 600	Discontinuous thickets of *Hardwickia-Pterocarpus-Anogessius* series
37	Singanapalli (Banaganapalle tk., Kurnaool dist.)	Southern Eastern Ghats; Tropical black clays; Stream of Kunderu	300-450; 600	Discontinuous thickets of *Hardwickia-Pterocarpus-Anogessius* series
38	Kesarapalli (Gannavaram tk., Krishna dist.)	Middle coastal plains; Deltaic alluvium; Stream of Krishna	10-50; 800-1000	Discontinuous thickets of *Hardwickia-Pterocarpus-Anogessius* series
39	Ponnekallu (Guntur tk., Guntur dist.)	Middle coastal plains; Tropical black clays; Stream of Krishna	10-50; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
40	Endroy (Guntur tk., Guntur dist.)	Middle coastal plains; Tropical black clays; Stream of Krishna	10-50; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
41	Chevapadu (Guntur tk., Guntur dist.)	Middle coastal plains; Tropical black clays; Stream of Krishna	10-50; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
42	Konduru (Tenali tk., Guntur dist.)	Middle coastal plains; Tropical black clays; Stream of Krishna	0-10; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
43	Godavarru (Tenali tk., Guntur dist.)	Middle coastal plains; Tropical black clays; Stream of Krishna	0-10; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
44	Nidumukkala (Guntur tk., Guntur dist.)	Middle coastal plains; Tropical black clays; Stream of Krishna	10-50; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
45	Lam (Guntur tk., Guntur dist.)	Middle coastal plains; Tropical black clays; Stream of Krishna	10-50; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
46	Amaravati (Guntur tk., Guntur dist.)	Middle coastal plains; Tropical black clays; River Krishna	10-50; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
47	Chebrolu (Chebrolu tk., Guntur dist)	Middle coastal plains; Tropical black clays; Stream of Krishna	10-50; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series

Sr. No.	Name of Site	Physiographic Zone / Soil Type / River System	Altitude (m) Rainfall (mm)	Vegetation Type
48	Edara (Nuzvid tk., Krishna dist.)	Middle coastal plains; Tropical black clays; River Tannileru	50-100; 1000-1200	Scrub woodlands of *Anogessius-Terminalia-Tectona* series
49	Dronadula (Chilakalur tk., Prakasam dist.)	Middle coastal plains; Tropical black clays; Stream Vogaruvagu	10-50; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
50	Thimmayipalem (Addanki tk., Prakasam dist.)	Middle coastal plains; Tropical black clays; River Gundlakamma	10-50; 800-1000	Closed thorny thickets of *Hardwickia-Pterocarpus-Anogessius* series
51	Ramayipalem (Addanki tk., Prakasam dist.)	Middle coastal plains; Tropical black clays; River Gundlakamma	10-50; 800-1000	Closed thorny thickets of *Hardwickia-Pterocarpus-Anogessius* series
52	Guntupalli (Addanki tk., Prakasam dist.)	Middle coastal plains; Tropical black clays; River Gundlakamma	10-50; 800-1000	Closed thorny thickets of *Hardwickia-Pterocarpus-Anogessius* series
53	Pedda Alavalapadu (Kanigiri tk., Prakasam dist.)	Middle coastal plains; Loamy ferrugineous tropical soils; River Paleru	100-150; 700-800	Closed thorny thickets of *Hardwickia-Pterocarpus-Anogessius* series
54	Tadigummi (Nandigama tk., Krishna dist.)	South coastal plains; Tropical black clays; Stream of Krishna	10-50; 1000-1200	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
55	Erullapadu (Nandigama tk., Krishna dist.)	South coastal plains; Tropical black clays; Stream of Krishna	10-50; 1000-1200	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
56	Pallagiri (Nandigama tk., Krishna dist.)	South coastal plains; Tropical black clays; Stream of Krishna	10-50; 1000-1200	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
57	Magallu (Nandigama tk., Krishna dist.)	South coastal plains; Tropical black clays; Stream of Krishna	10-50; 1000-1200	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
58	Santamagaluru (Narasaraopet tk., Guntur dist.)	South coastal plains; Tropical black clays; Stream of Krishna	50-100; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
59	Vemavaram (Narasaraopet tk., Guntur dist.)	South coastal plains; Tropical black clays; Stream of Krishna	50-100; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series

Sr. No.	Name of Site	Physiographic Zone / Soil Type / River System	Altitude (m) Rainfall (mm)	Vegetation Type
60	Senagapadu (Nandigama tk., Guntur dist.)	South coastal plains; Tropical black clays; Stream of Munneru	10-50; 1000-1200	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
61	Palapadu (Narasaraopet tk. Guntur dist.)	South coastal plains; Tropical black clays; Stream of Krishna	50-100; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
62	Jonnalagadda (Narasaraopet tk. Guntur dist.)	South coastal plains; Tropical black clays; Stream of Krishna	50-100; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
63	Gorrelapadu (Sattenapalle tk. Guntur dist.)	South coastal plains; Tropical black clays; Stream of Krishna	50-100; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
64	Muppalla (Sattenapalle tk. Guntur dist.)	South coastal plains; Tropical black clays; Stream of Krishna	50-100; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
65	Ganduluru (Sattenapalle tk. Guntur dist.)	South coastal plains; Tropical black clays; Stream of Krishna	50-100; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
66	Abburu (Sattenapalle tk. Guntur dist.)	South coastal plains; Tropical black clays; Stream of Krishna	50-100; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
67	Alugumillipadu (Palnad tk., Guntur dist.)	South coastal plains; Tropical black clays; Stream of Krishna	100-150; 800	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
68	Budada (Palnad tk., Guntur dist.)	South coastal plains; Tropical black clays; Stream of Krishna	100-150; 800	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
69	Naramalapadu (Palnad tk., Guntur dist.)	South coastal plains; Tropical black clays; Stream of Krishna	100-150; 800	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
70	Kanigiri (Kanigiri tk., Prakasam dist.)	South coastal plains; Tropical black clays; River Paleru	100-150; 800-1000	Closed thorny thickets of *Hardwickia-Pterocarpus-Anogessius* series
71	Tarlapadu (Markapur tk., Prakasam dist.)	South coastal plains; Tropical red loamy soils; Stream of Gundlakamma	150-300; 700-800	Discontinuous thickets of *Hardwickia-Pterocarpus-Anogessius* series

Sr. No.	Name of Site	Physiographic Zone / Soil Type / River System	Altitude (m) Rainfall (mm)	Vegetation Type
72	Sivapuram (Ongole tk., Prakasam dist.)	South coastal plains; Tropical black clays; Stream of Gundlakamma	10-50; 800-1000	Closed thorny thickets of *Hardwickia-Pterocarpus-Anogessius* series
73	Darsipadu (Addanki tk., Prakasam dist.)	South coastal plains; Tropical black clays; Stream of Gundlakamma	10-50; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
74	Mylavaram (Darsi tk., Prakasam dist.)	South coastal plains; Tropical black clays; River Gundlakamma	10-50; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
75	Konidene (Addanki tk., Prakasam dist.)	South coastal plains; Tropical black clays; Stream of Gundlakamma	10-50; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
76	Bobbepalle (Addanki tk., Prakasam dist.)	South coastal plains; Tropical black clays; Stream of Gundlakamma	10-50; 800-1000	Scattered shrubby facies of *Hardwickia-Pterocarpus-Anogessius* series
77	Nallagonda (Udayagiri tk., Nellore dist.)	South coastal plains; Sandy ferrugineous tropical soils; River Nalleru	150-300; 800	Closed thorny thickets of *Hardwickia-Pterocarpus-Anogessius* series
Karnataka				
78	Kodekal (Shorapur tk., Gulbarga dist.)	North Maidan; Tropical black clays; River Don	300-450; 600	Pseduo-steppe of *Anogessius-Chloroxylon-Albizzia amara* series
79	Maski (Lingsugur tk., Raichur dist.)	North Maidan; Tropical black clays; Stream of Tungabhadra	300-450; 600	Low scattered shrubs of *Albizzia-amara-Acacia* series
80	Piklihal (Lingsugur tk., Raichur dist.)	North Maidan; Tropical black clays; Stream of Tungabhadra	400-600; 600	Tropical thorn forest of *Albizzia-amara-Acacia* series
81	Tekkalakota (Siruguppa tk., Bellary dist.)	North Maidan; Tropical black clays; Stream of Vedavati	300-450; 600	Tropical thorn forest of *Albizzia-amara-Acacia* series
82	Sanganakallu (Bellary tk., Bellary dist.)	North Maidan; Red sandy loams; Stream of Hagari	300-450; 600	Tropical thorn forest of *Albizzia-amara-Acacia* series

Sr. No.	Name of Site	Physiographic Zone / Soil Type / River System	Altitude (m) Rainfall (mm)	Vegetation Type
83	Brahmagiri (Molakalmuru tk., Chitradurg dist.)	North Maidan; Black clays; Stream of Vedavati	400-600; 600	Tree Savanna of *Hardwickia-Anogessius* series
84	Hallur (Hirekerur tk., Dharwad dist.)	North Maidan; Black clays ; River Tungabhadra	400-600; 600	Tropical dry deciduous forest and thorny thickets of *Anogessius-Terminalia-Tectona* series
85	T. Narasipur (T. Narasipur tk., Mysore dist.)	South Maidan; Tropical black clays; River Cauvery	600-900; 700	Low scattered shrubs of *Hardwickia-Anogessius* series
86	Hemmige (T. Narasipur tk., Mysore dist.)	South Maidan; Tropical black clays; Stream of	600-900; 700	Discontinuous thorny thickets of *Chloroxylon-Albizzia amara* series
Tamil Nadu				
87	Paiyampalli (Tiruppattur tk., North Arcot dist.)	Tamil Nadu hills; Sandy ferruginous tropical soils; Stream of Ponnaiyar	300-450; 800	Scrub woodland of *Albizzia amara-Acacia* series
88	Chandrapuram (Tiruppattur tk., North Arcot dist.)	Tamil Nadu hills; Sandy ferruginous tropical soils; Stream of Pamban	300-450; 800	Scrub woodland of *Albizzia amara-Acacia* series
89	Gollapalli (Krishnagiri tk., Dharmapuri dist.)	Tamil Nadu hills; Sandy ferruginous tropical soils; Stream of Ponnaiyar	450-600; 800	Scrub woodland of *Albizzia amara-Acacia* series
90	Togarapalli (Krishnagiri tk., Dharmapuri dist.)	Tamil Nadu hills; Sandy ferruginous tropical soils; Stream of Ponnaiyar	300-450; 800	Scrub woodland of *Albizzia amara-Acacia* series
91	Kappalavadi (Krishnagiri tk., Dharmapuri dist.)	Tamil Nadu hills; Sandy loamy ferruginous tropical soils; Stream of Ponnaiyar	450-600; 800	Scrub woodland of *Albizzia amara-Acacia* series
92	Bargur (Krishnagiri tk., Dharmapuri dist.)	Tamil Nadu hills; Sandy loamy ferruginous soils; Stream of Ponnaiyar	450-600; 900	Scrub woodland of *Albizzia amara-Acacia* series

Sr. No.	Name of Site	Physiographic Zone / Soil Type / River System	Altitude (m) Rainfall (mm)	Vegetation Type
93	Pannimaduva (Harur tk., Dharmapuri dist.)	Tamil Nadu hills; Sandy ferruginous tropical soils; Stream of Ponnaiyar	300-450; 900	Scrub woodland of *Albizzia amara-Acacia* series
94	Dailamalai (Harur tk., Dharmapuri dist.)	Tamil Nadu hills; Sandy ferruginous tropical soils; Stream of Ponnaiyar	300-450; 900	Scrub woodland of *Albizzia amara-Acacia* series
95	Mullikadu (Harur tk., Dharmapuri dist.)	Tamil Nadu hills; Sandy ferruginous tropical soils; Stream of Ponnaiyar	450-600; 800	Scrub woodland of *Albizzia amara-Acacia* series

Human Ecology in Western India in the Second Millennium B.C.

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> "Human culture is the product of human nature, human history and human environment; each limits, yet each permits, the growth of individual creativity and the flowering of human society."
>
> (Campbell 1983: 17)

It is now generally agreed that human societies can be viewed fruitfully from an ecological perspective, and that the form and structure of cultures, as well as the psychological capacities of a particular group of people are directly explicable by reference to a few environmental factors. This is all the more true of the early farming communities which flourished in Western India in the second millennium B.C. These post-Harappan cultures share many common features such as a black-on-red painted ceramic, a specialised blade/flake industry of chalcedony, and copper which, however, being scarce, was used on a restrictive scale. Their mixed economy was based on subsistence agriculture, stock-raising and hunting-fishing. They all flourished in the black cotton soil zone which is semi-arid with an annual precipitation ranging between 400-1000 mm. The region comprises the western part of the Central Indian plateau stretching from the Vindhyas in the north to the Krishna basin in the south; in the east it is delimited by the eastern half of Madhya Pradesh whereas in the west it includes the coastal region of Gujarat but not that of Maharashtra which has a very high rainfall, and rocky uplands and therefore constitutes a different ecological zone. Western India thus broadly covers a very vast area comprising - Madhya Pradesh, South Rajasthan, Gujarat, Central Maharashtra and Northern Karnatak. It forms an ecological unit and hence the early farming cultures in this region shared many common features. They support the observation of Julian Steward that

> "The culture area is a construct of behavioural uniformities which occur within an area of environmental uniformities. It is assumed that cultural and natural areas are generally conterminous because the culture represents adjustments to the particular environment."
>
> (Steward 1955 : 35)

The present study examines the culture process in Western India from the perspective of environment. It must be at the outset admitted that the data at our disposal is very poor. However, some work has been done in Rajasthan to reconstruct the palaeoenvironment and the scientists have built up the following climatic sequence for Western India (Krishnamurthy *et al.* 1981).

Before 10,000 years BP	severe aridity
10,000 to 9500 years BP	relatively wet
9500 to 5000 years BP	relatively dry
5000 to 3700 years BP	sudden increase in wetness
3700 to 3500 years BP	relatively dry
3500 to 3000 years BP	relatively wet
3000 to 2500 years BP	arid

Although the climatic sequence given above is based on the palynological record from Rajasthan lake sediments, it can be taken to be valid to a certain extent for Western India in general. It can be interpreted to mean that the Mesolithic hunter-gatherers, who were occupying this area from about 10,000 years B.P. had a plentiful supply of plant and animal foods. Their population seems to have increased very fast as the wide distribution of microlithic sites would suggest and consequently many of them had to adapt to food production and the attendant settled way of life in the latter half of the third millennium. This was precisely the time when the enterprising Harappans had descended from Sind into Kutch and Saurashtra in search of raw materials and new arable lands for cultivation. In consequence, the opening of the second millennium witnessed the rise of self- sufficient village communities all over Western India save for Kutch and Saurashtra where the urbanized Harappans had already established their cities. The congenial climate till about

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1700 B.C. enabled them to flourish. But it was probably the adverse environment in the 4th-5th millennium combined with the fact that both plants and animal life may have become depleted, which may have forced the human groups to adopt the technique of food production. It has been observed that hunter-gatherers are generally reluctant to resort to food production.

> "It is sometimes assumed that food provides a more abundant life with less risk and smaller labour input than hunting and gathering." But this is a generalization that is not necessarily true; it may not be true at all for the majority of food producers... The earliest food producing groups in the New and Old Worlds did not always have more reliable or stable or nutritious subsistence base than their predecessors and may often have been worse off.
>
> Food production as a way of life is not a magnet that automatically attracts hunters and gatherers to participate in it actively... More typically, it is something that they are forced into by politically stronger groups and by economic or demographic pressure" (Smith 1972:4).

Cohen (1977) has also arrived at the same conclusion.

This would explain how the Mesolithic hunter-gatherers were being forced by climatic factors to become food producers because of the increasingly dry climate prevailing between 9500 to 5000 years B.P. The first half of the third millennium witnessed the rise of food producing communities in Saurashtra if the evidence from Lothal is any indication (Rao 1979 : 24-25), while in the latter half, it was in the Tapi valley that the people of the Savalda culture began to practice incipient agriculture (Sali 1963). The relatively wet phase in the third millennium was more congenial and this continued till around 1700 B.C. It was this phase which marked the emergence of the following archaeological cultures:

I. Rajasthan
  i) Ahar or the Banas culture (c. 1900-1200 B.C.)

II. Madhya Pradesh (Malwa)
  i) Kayatha culture c. 2000-1800 B.C.
  ii) Malwa culture c. 1700-1200 B.C.

III. Gujarat
  i) Prabhas culture c. 1800-1200 B.C.
  ii) Ragpur or Lustrous Red Ware culture c. 1500-1200 B.C.

IV. Maharashtra
  i) Savalda culture c. 2200-2000 B.C.
  ii) Malwa culture c. 1600-1400 B.C.
  iii) Jorwe culutre c. 1400-700 B.C.

The climate again becomes relatively dry between 1700-1500 B.C. when the Malwa people began to migrate into Maharashtra. The wet phase from 1500-1000 B.C. marks the emergence of the Jorwe culture. The severe aridity that set in at the end of the second millennium was perhaps the most important cause of the destruction of the Chalcolithic activity in Western India. The rise and fall of the Chalcolithic cultures in Western India corresponds very closely to the climatic sequences given above. The archaeological evidence thus bears out the dictum that like environment evokes like cultural responses.

Environment

Although the Chalcolithic cultures of Western India flourished in a semi-arid region, there are differences in the micro-environments of each zone. Southeast Rajasthan, the focus of the Ahar culture, is drained by the Banas and its tributaries. It is a gneissic plain about 475 m above the sea level, which forms part of the Mewar plateau. On the west it is delimited by the Aravalli Range which decreases in elevation towards the south. In the south-east lies the famous Malwa plateau, known for its fertile land and in the east is the Vindhyan plateau of Central India. It is through this corridor that the Ahar culture reached Malwa. In the southern part, where the soil cover is thin, the land is quite fertile. The annual rainfall is about 650 mm. The Mewar plateau is in fact the northward extension of the Malwa plateau.

Malwa is known since antiquity for its rich black cotton soil. It is the western part of the present state of Madhya Pradesh with the Vindhyas in the north and the Satpura Range in the south and in between lies the vast fertile basin of the Narmada. The Chambal also drains it in the north but forms part of the Ganga system. The annual precipitation ranges around 1000 mm. and, therefore, the region has a good vegetation cover and plentiful game too.

Gujarat is a plain of deposition developed by the Sabarmati, Mahi, Tapi and Narmada rivers. The region is characterised by three major geological features. The first is the Deccan Trap which dominates the Saurashtra Peninsula, parts of the southern mainland coast and Kutch. The other geological feature is the recent alluvium in the Rann of Kutch, north Gujarat plain and most of the coastal mainland. Northern Saurashtra and parts of the Kutch have limestone. Soil for the most part is the well known black cotton soil which abounds in Central India and the Deccan. The region is semi-arid with the annual rainfall ranging around 700 mm.

The most significant environmental features of Maharashtra are its plateau-like morphology, the shallow stream valleys, and the semi-arid monsoonal climate. Basaltic rocks occupy a major part of the state and the dolerite dykes and siliceous veins traverse these formations in various directions. Secondary pockets of cryptocrystalline silica such as chalcedony, agate, chert and jasper are common in the Deccan Trap. The continental, north-south running, divide of the Western Ghats separates the narrow coastal strip on the west from the uplands of the Deccan. Precipitation alls mostly from June to October during the south-west monsoon and is very high (5000 to 7000 mm per annum) on the crest of the Western Ghats. It decreases to about 00-700 mm in the rain-shadow region to the east. The most important climatic factor is rainfall, since year to year variability is very high and droughts are fairly common. According to H.H. Mann (1955: 1) Central Maharashtra is "one of the most, if not the most, precarious tracts in the ountry." The region is characterised by black cotton soil.

Settlement Organization

The early farming communities of Western India located their settlements in those areas where a perennial water upply and arable land was available. Usually they preferred the point where the river took a sharp meander because at this spot there was invariably a pool of water as at Kayatha and Inamgaon. Besides, the availability of pasture for domestic animals was also an important consideration. The earliest among the early farming communities, the people of the Kayatha culture, inhabited the western part of the Malwa region. Over forty sites of this culture have so far been discovered on the Chambal and its tributaries (Wakankar 1967). They are all very small settlements, not over 2 hectares in extent. A majority of them are located not on the main river, but on its tributaries obviously because of he danger of flood in the Chambal. In contrast to the small Kayatha settlements, those of the Ahar culture, at least two of them, were quite large. Ahar, the type site, is very extensive (500x270 m) and so also is Cilund (400x200 m) but most of the remaining sites range between 0.5 hectare to 2 hectares. Ahar, located in the picturesque setting, is very well protected by hills all around with only one opening on the northwest. The hills form a basin which has good soil, adequate rainfall and plenty of game.

In the Malwa phase, the number of settlements increases considerably and so also their size. The largest was at Navdatoli, over 10 hectare in extent, where there are hills on the north and south with the Narmada in between. Nagda and Eran were two other important centres of the Malwa culture for, though smaller than Navdatoli, they appear to have been fortified. Nagda probably had a rampart with mud brick bastions (Banerjee 1986:54) whereas Eran had a mud rampart (Singh 1962), the Chalcolithic date of which is suspect (Ghosh 1973; 62-63). A vast majority of Malwa sites are quite small, ranging from 1 to 4 hectare in extent. It is highly likely that the Vindhyan rock shelters were also occupied seasonally as hunting camps or for obtaining forest produce from hunter-gatherers (Joshi 1978: 84).

The Prabhas culture sites discovered so far are very few and they display a dispersed settlement pattern, but the intensive work of Gregory Possehl in central Saurashtra suggests that the Rangpur sites on the rivers Ghelo and Kalubhar are characterised by a linear pattern whereas the remaining are widely scattered (Possehl 1980: Fig.11). Possehl (1980: 61-63) has postulated a sharp decrease in population during the Rangpur period on the basis of the number of sites and their extent. But Rangpur itself, the type site, was undoubtedly a very large centre (Rao 1962-63).

Our knowledge of the Jorwe settlement pattern is somewhat better than that of the preceding cultures. Although over two hundred Jorwe sites have been discovered so far, the precise habitational area in each is hard to estimate at multiculture sites. A notable feature of the Jorwe settlement organisation is that there was a large centre in each region, e.g. Prakash in the Tapi valley, Daimabad in the Godavari Valley and Inamgaon in the Bhima valley. The largest of these was Daimabad, about 30 hectares in extent, whereas Prakash and Inamgaon would be around 5 hectares each. If we accept the modest estimate of 200 persons per hectare, the population of the regional centres would have been around 6000 to 1000 respectively. Daimabad, therefore, appears to be the primary regional centre which is also corroborated by the find of a unique hoard of bronzes having religious affiliation (Dhavalikar 1982). As regional centres, Prakash and Inamgaon were probably of equal importance. Prakash was a vertical dig and we do not know much about it, but Inamgaon was probably well fortified with a mud wall having stone rubble bastions. A similar feature has been noted at Daimabad also (Sali 1986 : 149 ff). In addition, the diversionary channel and the embankment on the western periphery at Inamgaon also may have afforded a measure of protection to the settlement.

A vast majority of the Jorwe settlements can be classified as villages. They are usually from 1 to 3 hectares in extent with their populations ranging from 200 to 600. A few of these villages such as Sonegaon, Chandoli and Apegaon have been excavated.

Nevasa and Bahal, however, were somewhat larger, with populations from 500-1000. Besides these, there are some sites which are very small, 0.5 to 1 hectare in extent, and consisting of a few households. An excellent representation of this class is Pimpaldar (district Nashik) which is situated in the historic Baghlan Pass linking the Tapi and the Godavari valleys. It may have served as a trading outpost considering the number of complete vessels it has yielded (IAR 1957: 58-66). All these belong to the category of hamlets whereas there are many others, especially in the Tapi valley, which can be identified as farmsteads. These are quite small, 0.5 to 1 hectare in area, but are situated close to villages about 2 to 3 km from it. They are like the present *wadis* of Maharashtra and may have facilitated the conduct of agriculture operations. They may have been occupied by a few families. A representative of this class is Walki, 35 km east of Poona, which was a Chalcolithic farmstead. It is about 2 hectares in extent and may have been occupied by a few families of agriculturists who lived there during the agricultural seasons. An example of a camp is furnished by the Pachad cave at the foot of the Raigad Fort which may have served as a meeting place for the people of the plateau and those of the coastal region.

A casual glance at the distribution of Chalcolithic sites in Maharashtra is enough to give a fair idea of the site spacing. There is a heavy concentration of sites in the Tapi valley, less in the Pravara-Godavari valleys and only sporadic occurrences in the Bhima valley. This gradual decrease in habitations from north to south is certainly due to the ecology of the respective river valleys and is governed by the principle of resource maximization and effort minimization. The Tapi valley is the most fertile topographic unit in Maharashtra; it has large tracts of rich black cotton soil with plentiful water supply from the Tapi. But a curious feature is that most of the Chalcolithic settlements here are located not on the Tapi itself but on its tributaries as is the case at present. According to Deshpande (1948 : 148-49) "The richest half is not the immediate banks of the Tapi, but the immediate plain in the danger of suffering rapid erosion-developed on the Black Cotton soil. Quite contrary to the general pattern of rivers, the Tapi discourages population concentration on its banks. Erosion and 'bad land' topography prevent irrigation and intensive cultivation." This also explains the prehistoric situation.

The Pravara-Godavari valleys, in sharp contrast to the Tapi valley, is characterised by undulating surfaces, at least in its upper reaches, where the early farming settlements are sparsely located. But in the lower reaches with rich black cotton soil, the number of settlements increases. The sparse habitation in the Bhima valley was probably due to the fact that the entire basin is dry with annual precipitation around 400-700 mm. and although the low-lying areas have black soil, the upland zones have very thin soil cover. The first farmers, therefore, selected only those pockets where arable land was available as at Chandoli, Sonegaon, Walki and Inamgaon.

From a careful analysis of the distribution of Chalcolithic sites a somewhat distinct pattern emerges. The Kayatha sites indicate a random pattern whereas the Ahar ones, situated only along river banks, are characterised by a linear pattern. This obviously is due to the scarcity of rainfall and the habitation therefore took place along the water courses where good soil was also available. The Malwa sites appear to be somewhat clustered around such regional centres as Nagda, Eran and Navdatoli whereas the Jorwe sites are dispersed. These observations are bound to be tentative in the absence of the requisite published data not only in respect of excavated sites but even in the case of explored ones.

Micro-Settlement Pattern

We do not know anything about the micro-settlement pattern of the Kayatha culture as the excavation at Kayatha was a small-scale dig. The Ahar people built rectangular houses some of which were quite large (7 x 5 m), sometimes with a partition wall. They had foundations of schist slabs over which were mud brick walls decorated with quartz nodules displaying a preference for white spots as in Bandhani fabrics and the painted black-and-red ware. The Malwa houses recovered at Navadatoli were also rectangular (3.5 x 2 m) with large enclosures. There were also round huts which were found in clusters (Sankalia *et al.* 1971: 61-63; Figs. 20 and 24). The Prabhas houses too were rectangular with walls of milliolite limestone set in mud masonry. The Rangpur houses, though rectangular in plan, were built of mud bricks (Rao 1962-63: 34-41).

The houses of different cultural periods at Daimabad make an interesting study. The Savalda houses were multi-roomed structures with low and walls, and so were the late Harappan dwellings in which the use of mud bricks conforming to the Harappan standard of 1:2:3 has been attested. But the Malwa and the Jorwe houses were single-roomed structures as at Inamgaon. At the latter site, however, there appears to be some modicum of planning the settlement because the houses were aligned in the northeast-southwest direction. This should not be surprising in view of the fact that even today the Kolams of Vidarbha plan their settlement properly. The houses of the Early Jorwe period at Inamgaon were smaller (5 x 3 m) than those of the preceding Malwa period and consequently no partition wall was necessary. The floor was well rammed. There were usually two hearths as in the Malwa houses; a small one inside for cooking the meal and a large fire pit in the courtyard for roasting the animals hunted. For storage there were pit silos dug into the ground and lined with lime, and round mud platforms (diameter 1 m) to serve as a support for storage bins of wickerwork, as is the case at present. The only multi-roomed dwelling of this period was probably that of the ruling chief. This contention is supported by the discovery of a unique burial in it as also by the location of the granary adjoining it.

There is a noteworthy shift in the micro-settlement pattern at the end of the second millennium. This was due to the drastic change in the climate which became more and more arid. This led to a decline in agriculture and the overall economic degeneration is reflected in small round huts and coarse painted pottery and gradually the people had to resort to sheep/goat pastoralism. The round huts, which were found in clusters of two, three or four at Inamgaon, had low mud walls, hardly 10 to 15 cm in height, with thatched walls and roof. There was a small round fire pit inside the hut and outside as well, but there were no pit silos and bin platforms, for there was not enough grain to store as in the Early Jorwe period; instead there was, in every hut, a set of four flat stones for supporting a four-legged storage jar. In the 8th century B.C., in the closing phase of the Late Jorwe period the huts became extremely flimsy, with an irregular plan and without a well-made floor. There was probably no wattle-and-daub construction above the low mud wall, but only the thatched roof which was very low.

A noteworthy feature of the Jorwe (both Early and Late) settlement at Inamgaon was that the houses of the artisans such as the potter, the goldsmith, the lapidary, etc. were located on the western periphery of the principal habitation area whereas the well-to-do people lived in the central part uggesting that it was a ranked society. This recalls to mind the present day community pattern in a Maharashtra village.

Subsistence

These early farming communities subsisted on farming, tock-raising and hunting-fishing. They reared cattle, sheep/goat, buffalo and pig, which were also slaughtered for food. Their subsistence agriculture was mainly dry farming since Western India and the Deccan is a semi-arid zone, with the annual rain-fall ranging between 4000-1000 mm. They also enjoyed the facility of artificial irrigation which is attested to at Inamgaon. The soil except in Rajasthan, was the black cotton soil, which is known for its productive potential and moisture retention capacity. In south-east Rajasthan, the home of the Ahar culture, the soil is rather loamy and quite fertile. But the monsoon being erratic, then as now, agriculure must have been a gamble with nature, for even today every third year is a bad year and every fourth one of famine.

A variety of crops were grown, the Jorwe farmers even practised crop rotation, kharif and rabi, as is also done today (Kajale 1988). The evidence from Inamgaon gives us a fair idea of the early agriculture, whereas from other regions the evidence for agriculture is relatively poor. The principal cereal was barley (*Hordeum vulgare*), but wheats (*Triticum* spp.) too were cultivated in areas which receive winter rains as in Malwa. Rice is reported from Inamgaon (probably as a result of inter-cultural relations) and the long seeded variety (*Oryzo sativa* Lin.) from Ahar. Bajra (*Pennisetum typhoides*) occurs at Rangpur, but more interesting is jowar (*Sorghum vulgare*) in Jorwe Culture (Kajale 1977). Bajra was probably introduced into Saurashtra from East Africa in the beginning of the second millennium. Mention should also be made of kulith (*Dolichos biflorus*) and ragi (*Eleucine corocana*) which were the staple grains of the Neolithic farmers of the Southern Deccan. Besides, there were the green pea, grass pea (*Lathyrus sativa* Linn.), lentil and green and black gram. A most interesting cultgen is the hyacinth bean (*Dolichos lablab*) from Inamgaon.

Evidence for plant economy from Daimabad and Inamgaon is quite rich so far as the Malwa and the Jorwe periods are concerned, whereas during the Savalda period (c. 2200-2000 B.C.), it was extremely poor. The Savalda people practised incipient agriculture and they appear to have subsisted more on hunting-gathering and fishing.

The evidence from Daimabad shows that the Malwa and the Jorwe periods were quite prosperous. Among the grains represented there are both kharif (summer) and rabi (winter) corps (Kajale 1977). The principal cereal was barley (*Hordeum vulgare*); wheat too occurs at Daimabad.

There is no doubt that fishing formed an important part of the diet of the Chalcolithic people as is evident from fish bones, fish hooks and the fish motif on pottery. Especially noteworthy is the aquifauna so exquisitely depicted on the Savalda-ware (Sali 1963). But the most curious is the presence of short-life vertebrae at Inamgaon which may have come either from Kalyan or Mahad, the nearest creek ports, about 200 km west of Inamgaon (Thomas 1988). Hunting also was equally important. The people had developed a weakness for venison. Wild pig too occurs. The domesticated animals were slaughtered for food, but whether their milk was consumed or not is problematic, for it has been observed on the basis of ethnographic analogues, that the early farming communities may not have milked their cattle and sheep/goats (Sherratt 1981: 275-77). Even the Gonds of Bastar think that the milk is only for the young animals and do not milk their cattle.

We can draw far-reaching conclusions in respect of the Chalcolithic diet by scientific studies. The multi-elemental analysis including strontium, zinc, copper and manganese, of human skeletal remains from the burials discovered at Inamgaon indicates that the people of the early Jorwe period subsisted more on plant foods and agriculture products even though meat also formed a part of their diet. As compared to this, the late Jorwe people subsisted more on animal foods. This supports our inference that agriculture was on the decline during the late Jorwe as a result of increasing aridity which set in around the close of the second millennium and gradually the people resorted to sheep/goat pastoralism, if the evidence of animal bones is any indication.

Another important conclusion that we can draw is that during the first two cultural periods till the age of about ½ to 1 year the children were fed on mother's milk but in the late Jorwe phase/period they were weaned at the age of 2 to 2 ½ years. This possibly is due to the sedentary life of the early farming communities during the Malwa and the Early Jorwe periods, but because the late Jorwe people had to resort to a semi-nomadic existence owing to drastic climate changes consequently the children had to rely more on mother's milk for a longer period. Similar evidence is also available from other parts of the Old and New worlds.

All these early farming cultures flourished in the black cotton soil zone. This, according to Leshnik (1968: 295), "clearly represents an ecological adaptation dictated by available technology, knowledge and means. An analogy with the present day agriculture methods in these regions leads to the supposition that we are dealing here with a system of dry farming, dependent on moisture retentive soils."

It has been observed that environment of a particular region offers possibilities and also limitations for human adaptation and the manner in which human beings adapt, in turn, affects the natural surroundings. This is true of the region in which the early farming communities flourished. The black cotton soil which seems to have been the most important single factor in the formation of these cultures, offered possibilities and limitations too. The hard, compact black soil is known for its productive potential and moisture retaining capacity; it is capable of yielding rich harvests if cultivated effectively. It has been argued that the Chalcolithic agriculture was generally confined to alluvial patches (Agrawal 1982 : 218) and that the black cotton soil could not have been cultivated in the absence of an iron plough (Kosambi 1963: 16). It must be explicitly stated that the rivers in the Deccan run through hilly uplands and therefore do not deposit the fertilizing silt on their banks as do those of the Indo-Gangetic plain (Panikkar 1959: 37). Our estimates of population at such large centres as Daimabad and Inamgaon, respectively of 1000 to 6000, would show that enough grain could not have been produced if only the alluvial patches were cultivated. There is evidence to show that the early farmers cultivated the black soil also (Dhavalikar and Possehl 1974). The agricultural history of Europe shows that "Pollen studies and other archaeological research point to the worldwide use in the neolithic period of a system of cultivation of forest plots, probably very much resembling the type of cultivation that is now found in many primitive communities. This contrasts with an earlier theory according to which intensive cultivation in river valleys would have preceded the cultivation of forest land. The older theory seems to have been based upon the view that forest land was too difficult to cope with for very primitive people. This, however, ignored the fact that not felling but fire was the method of clearing forest land, and it seems that experts in the field now tend to think that river shore cultivation may have been taken by the descendant of tribes who had lost the forest land they had cultivated owing to desiccation or exhaustion and sided by crowding along the rivers" (Boserup 1965: 17).

That the forest land, and not alluvial strips along the river banks, was cultivated by the early farming communities is indirectly corroborated by the type of tool used by them. Neither plough nor hoe has been attested to at Chalcolithic sites, but perforated stone discs, which were probably used as weights for digging sticks, abound. The digging stick can be useful only in the slash-and-burn or Jhum cultivation. Plots of the forest land are easy to clear by burning trees, after which the clumps of the trees remain, and no plough or hoe can be used, Sowing and planting can be done directly in the ashes, without any land preparation and without the use of any tool other than perhaps a digging stick to scratch the ashes or punch the holes in which to plant the roots or sow the seeds. It is not possible to use a plough on land cleared by this method. But under the Jhum cultivation, the land has to be kept fallow after one or two years. It takes about 25 to 30 years for the forest to grow again, but by constant use the forest will give place to small bushes for some time and finally the land will be completely cleared for annual cropping. The plough can be effectively employed only on such type of land.

The problem of the plough has also to be explained satisfactorily. The famous adage that "the black cotton soil ploughs itself" is not without significance. During summer it develops large, deep fissures which help in the circulation of air, thus fulfilling the function of the plough. The black soil may have been cultivated by means of a wooden plough as is done even today in Malwa. It is also highly likely that antler: which have been found in excavations, may have been used as ploughs. In Europe they were used for mining flint in Neolithic times. It is interesting to note that wooden hand-plough which was used in the Deccan in the last century resembles an antler (Wallace 1888: 168).

Our knowledge of early agriculture is still sketchy owing to the fact that sufficient attention was not paid in the earlier excavations to the recovery of grains. Inamgaon is the sole exception, for here, a vast quantity of charred seeds was collected by floatation as a result of which we can now reconstruct the history of agriculture in the Deccan. The early Jorwe phase (c.1400-1000 B.C.) was a period of prosperity. The farmers cultivated four cereals (wheat, barley, rice and jowar) and four pulses (horse gram, hyacinth bean, lentil and field pea) which is not done even today. The people seem to have used their scarce resources, especially water, very economically and intelligently or else they would not have been able to raise such a variety of crops. The problem, however, is that the region is semi-arid with hardly 450 mm of rainfall and is perpetually drought-affected and hence the cultivation of so many crops is enigmatic. What they did was to divert the flood waters through a channel (extant length 118 m, 3.50 m deep, 4 m wide) and a sort of guide-bund or an embankment was built parallel to it. Its basal courses were of stone rubble set in mud mortar and the upper portion was earthen. The channel was deep in the middle (3.50 m) and thus served also as a narrow tank for storing water which was probably used for pot irrigation. The traces of the channel suggest that the water could have been diverted to the adjoining fields by gravity flow. There may not have been much loss of water by way of seepage as the channel has been dug upto the rock bottom and its sides into the pulverised rock (*murrum*). Probably because of this facility of artificial irrigation the early Jorwe farmers could cultivate wheat and hyacinth bean. Rice may have been grown in small, carefully tended plots, wherein rain water was ponded as is the case today. The irrigation fell into disuse after c.1000 B.C. A similar ditch and embankment has also been laid bare at Malvan, a coastal settlement near Surat in Gujarat (Allchin and Joshi 1972). It is highly likely that the facility of artificial irrigation was available at other Chalcolithic sites also because the climate was relatively wet in the latter half of the second millennium (Krishnamurthy *et al.* 1981). But even during this period there were two phases of intense aridity, first in the middle of the millennium and later in the 13th century B.C. This is reflected stratigraphically in the excavations at Inamgaon in layers (12) (8) and (4) respectively. These layers do not contain any floor levels, nor have they yielded charred seeds in the quantities in which they were found in the preceding levels; on the other hand there is a tremendous increase in the quantity of animal bones in them. It is, therefore, highly likely that they mark a period of droughts in Maharashtra.

Aridity again sets in at the close of the second millennium, but it is so severe this time that the early farming communities had to abandon their settlements. Everywhere in Central, Western India and the Deccan all human activity comes, as it were, to a grinding halt. The settlements were deserted only to be occupied later in the Historical period in 6th-5th century B.C. This break in the habitation is stratigraphically reflected by a sterile layer at Nevasa and also at several other sites such as Kayatha and Prabhas-Patan indicating a break in occupation. Our examination of the exposed sections at Nagda and Prakash have also revealed such a stratum. It would, therefore, be clear that the principal cause of the downfall of the early farming societies in Western India and the Deccan was the drastic climatic change which ushered in increasing aridity that lasted for about five centuries or so till 5th century B.C. (Rajaguru 1983; Kale and Rajaguru 1987).

It is interesting that almost at the same time i.e. 1000-400 B.C. Europe was experiencing a Little Ice Age (sub-Boreal phase) which forced people to resort to pastoral nomadism (Khazanov 1986: 95).

Almost all the palaeoclimatologists accept that the second millennium B.C. was characterised by dry climate which, it would appear, was at its driest at the turn of the second and the first millennium B.C. Archaeological data would also confirm this suggestion.

The fact that these dates coincide with the period of emergence of pastoral nomadism, as it has been established by archaeological data and written sources, is scarcely due to chance. It would appear that the dry climate was the final stimulus for pastoralists to abandon agriculture once and for all and become fully nomadic (Khazanov 1986: 95).

Conclusion

A very important observation made by scientists is that "whenever the high latitudes cool, the monsoons tend to fail" (Sulman 1982: II, 118). In the light of this observation the severe aridity in Western India during the first half of the first millennium almost exactly corresponds with the cold phase in Europe.

In Central Maharashtra, however, the climatic change does not appear to be very drastic, more particularly in the Bhima valley where the settlements were not abandoned by the Chalcolithic people. They continued to survive but in a poor state and their poverty is reflected in their small round hunts, coarse painted pottery and decline in agriculture. At Inamgaon, the irrigation channel fell into disuse for want of water and hence wheat could not be grown. There is evidence to show that gradually the climate was becoming more and more adverse and in consequence people were slowly reverting to sheep/goat pastoralism. It has been observed that circular dwellings tend to correlate with a nomadic or semi-nomadic way of life, whereas rectangular dwellings indicate fully sedentary societies (Flannery 1972; McGuire and Schiffer 1983: 284). In the earlier phase of the late Jorwe period at Inamgaon a majority of round huts were found in clusters of three or four or five suggesting that a large segment of population was leading a semi-nomadic existence. The upper levels of the late Jorwe were characterised by extremely flimsy structures, irregular in plan and without well-made floors. It is in these levels that the proportion of sheep/goat bones increases to 72% from 25% in the beginning of late Jorwe whereas that of cattle decreases from 53% to 14%. At the same time, bones of deer increase from 5% to 14% indicating a greater reliance on hunting (Thomas 1988). It has been observed that weeds and herbaceous plant species like purslane, goosefoot, solanaceous plants, Indian mallow etc. tend to suggest that collection of wild plants might have been a regular practice due to overall impoverishment in the farming system during the late Jorwe (Kajale: 1988). All the evidence leads us to conclude that the drastic climatic change around the beginning of the first millennium gradually led to a decline in agriculture resulting in a shift from sedentism to sheep/goat pastoralism and ultimately forcing the people to abandon their settlements. Probably the incursions of megalith builders from the southern Deccan were also partly responsible for this.

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The Study of Settlement Patterns in the Cōḷa Period: Some Perspectives

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The historical geography of the Tamil country is an area of comparatively recent interest among historians and geographers. There is no single work to date which makes a serious attempt to study the settlement pattern of the Cōḷa period both in time and space. A project was started more than a decade ago to produce a historical atlas of Tamil Nadu. Though initially thought to be a modest and manageable task, it was in fact found to be a formidable one, beset with many problems, not the least of which was the methodology of using inscriptional data. A more direct hurdle has been the identification and location of sites, a problem common to all such efforts. It became increasingly necessary to improve and refine methods as one went along. One of these pointed to the need for correlating data on geographical content, eco-systems and the locational significance of different types of settlements. Such background data is not readily available in the inscriptions themselves, which are the major source for the medieval period in South Indian history.

The only work which has made its mark in this direction is that of Subbarayalu (1973) on the political geography of the Cōḷa country (1973). This has, however, devoted itself mainly to institutional history rather than to the study of human geography. The work, further, confines itself to Cōḷa maṇḍalam i.e. the region of the Kāvēri delta and its immediate neighbourhood and Naduvil Nāḍu, to the north of it. There is little doubt that it is the first systematic study of the *nāḍu*, prominently referred to in Cōḷa inscriptions. The admirable handling of the epigraphic data does provide a new perspective to the agrarian organisation by establishing that the *nāḍu* was an agricultural region, an eco-type based on kinship ties and not an artificial unit created by a political power, although it was recognised by the Cōḷas as a viable administrative unit. The contribution of this work to an understanding of the Cōḷa society and state is basic and has, in fact led to a significant turn in Cōḷa historiography. It has provided the starting point for the theory of the segmentary state in medieval South India, where the *nāḍu* is used as the segment and a highly autonomous one (Stein 1980), and for the study of the *nagaram* or market-centre by Hall (1980), according to whom the *nāḍu* was the marketing region for the *nagaram*. Added to these are essays on the sacred geography of the Śaiva *bhakti* hymns (Spencer 1969,1970) which supplement the theory of the "ritual sovereignty" of the Cōḷa rulers as a necessary and complementary aspect of the "segmentary" character "peasant" society and state in medieval South India.

Together these works provide a fairly dependable perspective on the distribution of peasant eco-types, sacred centres and market centres. Their main concern, however, is to show the processes or stages in the emergence and proliferation of different types of settlements and the factors which determined their ecological setting and geographical location. Even the commendable work of Subbarayalu (1973) concentrates on the middle Cōḷa period, which, in fact, represents the end of the main phase of agrarian expansion in the Cōḷa region, not the stages of such expansion. The erstwhile Pallava and Pāṇḍya regions are important for an understanding of the Cōḷa settlements as the Cōḷa heartland and their historical geography is just beginning to emerge.

The two major types of settlements, the *Brahmadeya* and the temple centre, have also been the subject of studies, which are more concerned with surveying the history of individual centres than the understanding the interconnection between them and the agrarian expansion or urban growth. Considering the lacuna in the existing literature on the subject, it would be more meaningful if one's efforts are directed towards a comprehensive approach which deals with all the regions in the Tamil country under the Cōḷas, both for purposes of comparison and chronological differences and changing patterns, if any, in human geography.

Cōḷa rule extended over the whole of the Tamil country, within which sub-regions (Fig.1) are distinguishable on the basis of historical, geographic and climatic factors. It also for some time penetrated into the adjacent tracts in South Karnataka and Andhra Pradesh. In geographic terms, the region, with the Kāvēri Valley as its core, covers the northern

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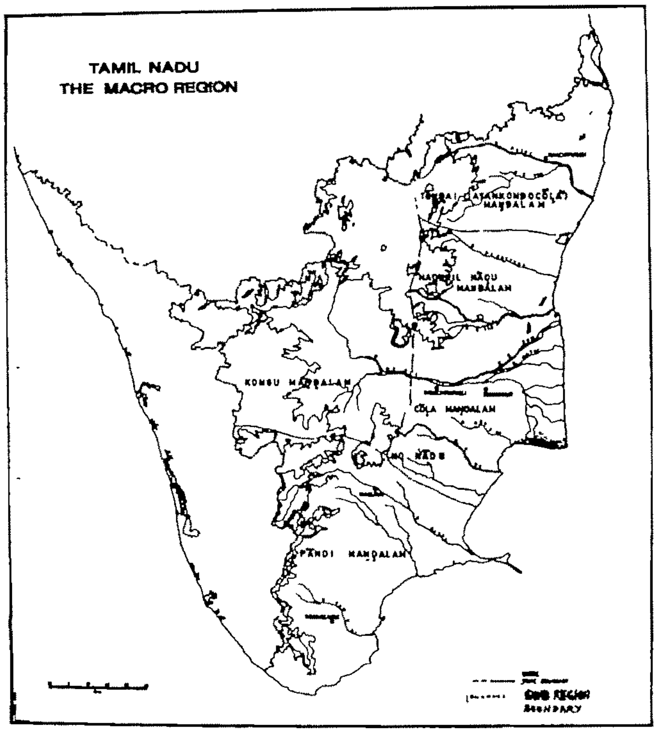

Fig. 1: Tamil Nadu the macro-region

plains watered by the Palar and Cheyyal, along with other streams. The Southern plains are drained by the Vaigai and Tamraparni. Each of these rivers forms the core of a sub-region, the "perennial nuclear regions" in the words of Spate (1954: 148) i.e. Toṇḍaimaṇḍalam, Cōḷa Maṇḍalam and Pāṇḍi Maṇḍalam, with buffers between each of them. The region from the South Pennar to the Vallar rivers, later known as Naḍuvil Nāḍu, lies between Toṇḍaimaṇḍalam and Cōḷa Maṇḍalam. The semi-arid Pudukkottai region separates the Cōḷa and Pāṇḍya countries. The western boundary of the plain is marked by the plateau and the sharp topographical breaks caused by the upthrusting Eastern Ghats and ranges. The area thus created forms the uplands, parts of which lie in the upper reaches of the Kāvēri and form yet another sub-region viz. Kongu Nāḍu or maṇḍalam of the Tamil macro-region.

The origin of these sub-regions may be traced back to the early Christian era and attributed to their early occupation by the traditional Tamil trio, the Cēras (Kongu), Cōḷas (Kāvēri) and Pāṇḍyas (Vaigai-Tamraparni) and early chieftaincies like the Tondaiyar of Kacci (Kāñcīpuram). Their development as agrarian regions, resource bases and cultural sub-regions took place over several centuries (7th-13th centuries). The earlier period was that of the Pallavas and Pāṇḍyas (7th to 9th centuries) followed by the Cōḷas (9th to 13th centuries), particularly the last of them. During this period the sub-regions were systematically integrated and organised through institutional means, i.e. the *Brahmadeya* and the temple. In a sense, the macro-region evolved with the distinctive socio-political culture which developed under the Cōḷas. Such a claim is unacceptable to the protogonists of the "Segmentary State" theory according to whom the Cōḷas exercised only a ritual sovereignty over a "segmentary" state. However, it is conceded by them that at the zenith of Cōḷa power, that part of the southern peninsula, which fell under the Cōḷa over-lordship was the macro-region (Stein 1980: 75).

In the early centuries of the Christian era, the concept of the five *tiṇais* (eco-cultural zones) in the Sangam classics, reflects an understanding of the close man-nature relationship i.e. the harmony between culture and geography (Sivathamby 1974). The *marudam* or the riverine plain was the agricultural zone, the gradual colonisation of which is indicated in the Sangam works. A symbiotic relationship among different zones and at the same time a constant expansion of the peasant frontier of encroachment of peasant agriculture into the peripheral *mullai* or forest region are also reflected in the same works. The efforts to clear forests and hill tracts must have been continuous as seen in the antagonism of the hill folk to the plains people. Although the stages are not clear, by the 7th century A.D. agriculture had gained undisputed dominance and the *tiṇai* (or five eco-zones) concept was replaced by the three types of land viz. wet, dry and mixed. This is well attested to in the epigraphic and literary sources of the 7th-9th centuries A.D. The changing pattern shows a decisive shift during the Pallava period from isolated territories with their cities in older agricultural tracts to new rural centres (Stein 1980: 69). This happened in all the core regions although it is most evident in the Kāvēri plains, which had become the best of the *marudam* zone with denser settlements, particularly in the delta. Even after the 7th century the encroachment of peasant agriculture into non-agricultural areas continued, the pace, however, not being always rapid.

The Kāvēri delta falls within the 75 m contour. To the west of it, for a forty mile stretch, lies the plain extending from Tiruchirapalli to Karur and falls between the 75 m and 150 m contours. This is less densely settled than the delta. Colonisation of this region by settled communities practising agriculture was at a pace faster than in any other part in the early centuries. Archaeological evidence of BRW sites and the Sangam works point to a series of habitation sites, which existed in "mutual harmony" in the early period. (Champakalakshmi 1975, 1976).

The delta must have posed two major problems from the beginning of its colonisation 2000 years ago. The land, sloping eastwards a little too steeply for a delta, led to an unceasing struggle between man and the problems of floods and changes in the courses of rivers and canals due to silting (Subramaniam 1984: 57). The story of the taming of the delta was not as dramatic as is believed by historians. They have, on the basis of legends and traditions attributed the building of embankments and also of the *Kallaṇai* (Grand Anicut) which rendered the delta to Karikāla who ruled during the

2nd century A.D. In reality, the productivity of the delta was achieved in stages depending upon needs and resources. Although the settlement pattern in this early period is not yet fully known as the archaeological data is incomplete, the tendency for settlements to concentrate in the northern part of the delta is indirectly corroborated by reference to settlements on either banks of the Kāvēri in the *bhakti* hymns of the 7th-9th centuries. More important is the fact that from the 9th century onwards the Kāvēri is the reference point for the location of *nāḍus* either on its northern or southern bank as learnt from the earliest Cōḷa inscriptions of the 9th-10th centuries. The colonisation of the northern parts on a larger scale by the 9th century and the relatively sparse settlements in the southern delta is also indicated by village names with the *kāḍu* suffix in the southern taluks of Tanjāvūr district, a substantial part of the region being supported by a pastoral economy. This is further confirmed by the more frequent occurrence of cattle and sheep (goat) donations in the early Cōḷa inscriptions and the increase in land donations from the end of the 10th century. The salt swamps of the Vēdāraṇyam region remained much more sparsely inhabited till the 12th century. Then a few scattered villages appeared and two new *nāḍus* seem to have been formed within the Umbaḷa Nāḍu (Subbarayalu 1973: 49).

The main Kāvēri river, after its bifurcation into two branches (Koḷḷiḍam and Kāvēri) at the head of the Śrīrangam island (where the Akhanḍa Kāvēri or undivided Kāvēri ends) is represented by the smaller courses south of Koḷḷiḍam. The Veṇṇār, further south, which branches off a little to the west of the Grand Anicut has 14 distributaries. The Kāvēri is now represented by the small insignificant channel that hardly reaches the sea at Kāvērippūmpaṭṭiṇam. It has no resemblance to the wide navigable river in full spate as described in the Sangam works and later epics. In earlier times the Kāvēri and the northern courses tended to draw more water than the Veṇṇār. The Sangam Cōḷas adopted the mud embankment strategy and bunding to create canals to contain the river, which started off the integration of the northern parts of the delta, a process which was continuous and seems to have become well-established by the 8th-9th centuries and was continued by the imperial Cōḷas. In fact, Pallava records show the aspirations of this dynasty to occupy the "rich" land of the Kāvēri, the girdle of the Tamil region. To Karikāla is attributed the early deforestation and introduction of cultivation in the region: "*Kāḍu Koṉṟu nāḍākki*". Land reclamation was continuous.

The phased opening of the Coromandel Plain, as pointed out by Stein, provides one of the most important factors of agrarian periodisation for South India and the gradual settlement of the plain with sedentary "peasant communities" (Stein 1980: 37). However, for the Palar-Cheyyar Valley in the north, with the exception as of Kacci (Kāñcīpuram) and its port Nīrppeyaṟṟu, we have much less significant evidence of colonisation in the early period. The opening up of the Vaigai-Tamraparni Valleys (i.e. Pāṇḍya region) is better attested to although it was much less intensive than in the Kāvēri delta. It is only for the period starting from the 7th century and more clearly from the 9th century A.D. (i.e. the rise of the Cōḷas) that the evidence for the opening up of the land for settled agriculture in all the three regions is forthcoming.

The *nāḍu* (literally cultivated area), as ably demonstrated by Subbarayalu, is the very key to the political geography of the Cōḷa country, a very important limb of the Cōḷa administrative system and the basic unit of the then agrarian society (Subbarayalu 1973: 19). The study of the *nāḍu* provides a clearer perspective to the understanding of the settlement pattern under the Cōḷas. The *nāḍu* was not an artificially created unit and except only very few exceptions, did not have natural boundaries. The *nāḍus* pre-dated the Cōḷa period as a basically agrarian region, "a peasant micro-region" and an economic as well as ethnic territory.

A study of the *nāḍu*, its emergence and proliferation would, therefore, provide the clue to agrarian expansion and the character of the settlements within it. The chronological sequence of its emergence, which can be done with the help of contemporary inscriptions, may be expected to provide a remarkable corroboration of the integration of the less developed, pre-existing settlements having no irrigation or other facilities, in the newly created *Brahmadeya* and temple uncleated centres. To a large extent this method has been ably used for Cōḷa Maṇḍalam by Subbarayalu (1973). He shows that by A.D. 1300 there were 140 *nāḍus* (and *Kūṟṟams*) in Cōḷa Maṇḍalam and 65 in Naḍuvil Nāḍu, which evolved as a separate unit under the Cōḷas (Fig.2). On the basis of their first occurrence in inscriptions, Subbarayalu (1973) suggests an "evolutionary character" for the *nāḍu*. Its subsequent proliferation or increase over the long period of Cōḷa rule is taken as an indicator of its expansion into cultivated areas and hence an increase in settlements.

Nāḍu distribution (after Subbarayalu 1973)

Period	Cōḷa Maṇḍalam	Naḍuvil Nāḍu
A.D. 800-900	Few known (2)	3
900-1000	54	11
1000-1050	49	17
1050-1200	19	18
1200-1300	12	5

Based on this data, and given the optimum conditions then, the density of population is believed to have reached a point of saturation, in the first half of the 11th century, after which the rate of growth was slow. In the Naḍuvil Nāḍu, a faster rate is recognised till the middle of the 12th century, after which it slowed down, with the new units generally coming up in relatively less fertile areas. Stein rejects this

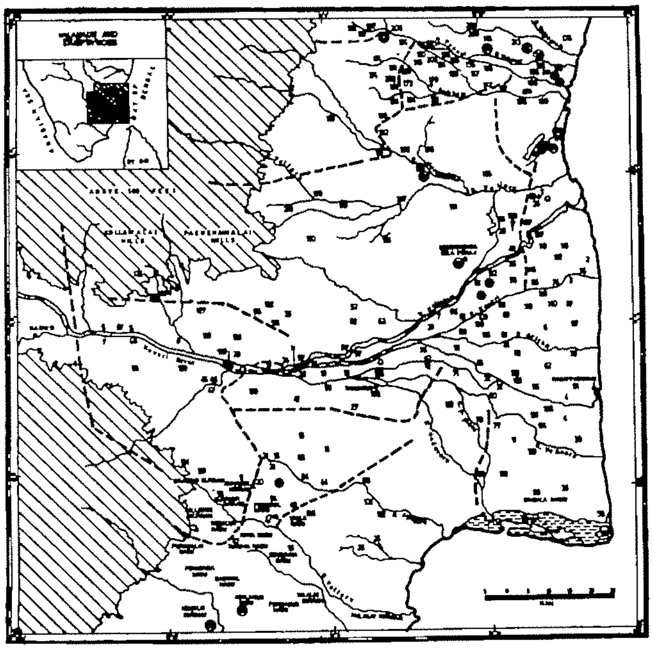

Fig. 2: Cōḷa Maṇḍlam

view of an evolution or unfolding of locality units as a result of saturation. According to him such an impressive population of growth by 11th century is an "undemonstrable" assumption. Instead Stein proposes that most of 550 *nāḍus* (including those in other regions) referred to in Cōḷa times were in existence during the time of Rājarāja I (985-1014), and that the reference to them indicates not a new existence, but a new recognition of Cōḷa over-lordship since they provided the basis for the Cōḷa political order (Stein 1980: 98). The difficulties in Stein's proposition are manifold. It sets an arbitrary chronological limit for the emergence of all the *nāḍus* and ignores the need to explain the factors leading to such a large increase in *nāḍus* before the Cōḷa period i.e. phenomenal agrarian expansion over the entire macro-region.

The 550 *nāḍus* listed so far, include those of the Toṇḍaimaṇḍalam and Pāṇḍimaṇḍalam. For the Pāṇḍya region, a total of 66 agrarian localities (*nāḍus* and *kūṟṟams*) have been listed and to this, the Cōḷa inscriptions from the same region add 29 for the period from the 10th to the 12th centuries, when the Pāṇḍya country was under Cōḷa occupation. In the northern plains of Toṇḍaimaṇḍalam of the 180 *nāḍus* listed from Cōḷa inscriptions not even one-fourth are known from the Pallava records before the 9th century. This is also the situation in the Kongu region, the tableland, which is a secondary agrarian core in South India.

The common features shared by the *nāḍus* of all the sub-regions are their size and distribution. *Nāḍus* are smaller in size with a greater density of settlements in the fertile river valleys, while the bigger *nāḍus* are found in relatively less fertile territory and in most cases on the fringes of the core regions (Subbarayalu 1973: 22; Gurukkal 1984: 102). The area of a *nāḍu* in Cōḷa maṇḍalam ranged from 10 to 300 square miles i.e. on an average 24 square miles. Of the 1070 villages for 140 *nāḍus*, the largest number are found in the delta with one village for every 2, 3 or 4 to 6 square miles. Of the 223 sites listed for Naḍuvil Nāḍu, the distribution is similar i.e. the riverine settlements in the lower reaches of the Pennar, Manimuttar and Gadilam being denser than those in the upper reaches as well a in the periphery.

The *nāḍus* and *kūṟṟams* of the Pāṇḍya region occur in the fertile wet zone of the Tamraparni Valley, where two-thirds of them are concentrated in the modern Srivaikuntam, Tirunelveli and Tiruchendur taluks by the 10th century, and in the Ambasamudram taluk in the Cōḷa period. In the less fertile Ramanathapuram district, the settlements and *nāḍus* were scattered but a relatively denser distribution occurs in Tiruppattur, Sivganga, Aruppukkottai and Sattur taluks, the last one noted for its large irrigation works (Irunjola *nāḍu*) carried out in the 8th-9th centuries under Pāṇḍya patronage and a local chief's initiative. The agrarian localities in the Madurai and Kanyakumari districts were more sparsely distributed both in the pre-Cōḷa and Cōḷa periods. The pattern again is similar i.e. their proliferation was in the regions of relatively uniform rainfall, drainage, altitude, soil and temperature (Gurukkal, 1984: 105; Stein 1971; Ludden 1978), in the region either of alluvial soil or of the red and mixed soils best suited for paddy cultivation (Fig.3). They did not penetrate into the zones of black soil as in the case of the Kovilpatti taluk.

All the above instances together with Toṇḍaimaṇḍalam, where the evidence is much more directly related to irrigation works and their augmentation under the Cōḷas, show that it was the capacity of the irrigation source that determined the range of expansion both a settlement and a *nāḍu*. This is not a mere inference, for the names of several *nāḍus* in all these regions are derived from their irrigation sources or water courses around which they evolved e.g. Maṇṇi Nāḍu after Maṇṇiyar, Iḍaiyāṟṟu Nāḍu i.e. the land between two rivers in Cōḷa Maṇḍalam, Pulaleri kil Nāḍu and Ambattūr ēri kiḻ Nāḍu in Toṇḍaimaṇḍalam and Nāṭṭaṟṟuppōkku, Iḍakkuḷa Nāḍu, Vaigai vaḷanāḍu, etc. in Pāṇḍimaṇḍalam.

There are other significant features of the *nāḍu* regions, which deserve careful study. While nadus are generally named after a settlement, evidently the first settlement (only 66 out of 205 *nāḍus* in Cōḷamaṇḍalam) the later did not necessarily function as its centre or *nāḍu* headquarters. It is also interesting that there are examples, although too few to be of great significance, of *nāḍus* being named after a *Brahmadeya* or whose chief villages were *Brahmadeyas*. (Subbarayalu 1973: 32)]. By extension the *nāḍu* or *kūṟṟam* nomenclature came to be used even for areas of highly dispersed agricultural settlements or even those with other resources like salt (Umbaḷa, Aḷa and Iḍ ai Aḷa *nāḍus*) and where the major occupation was salt manufacturing, agriculture being only subsidiary. Interesting examples of *nāḍus* being named after the communities or tribes occupying

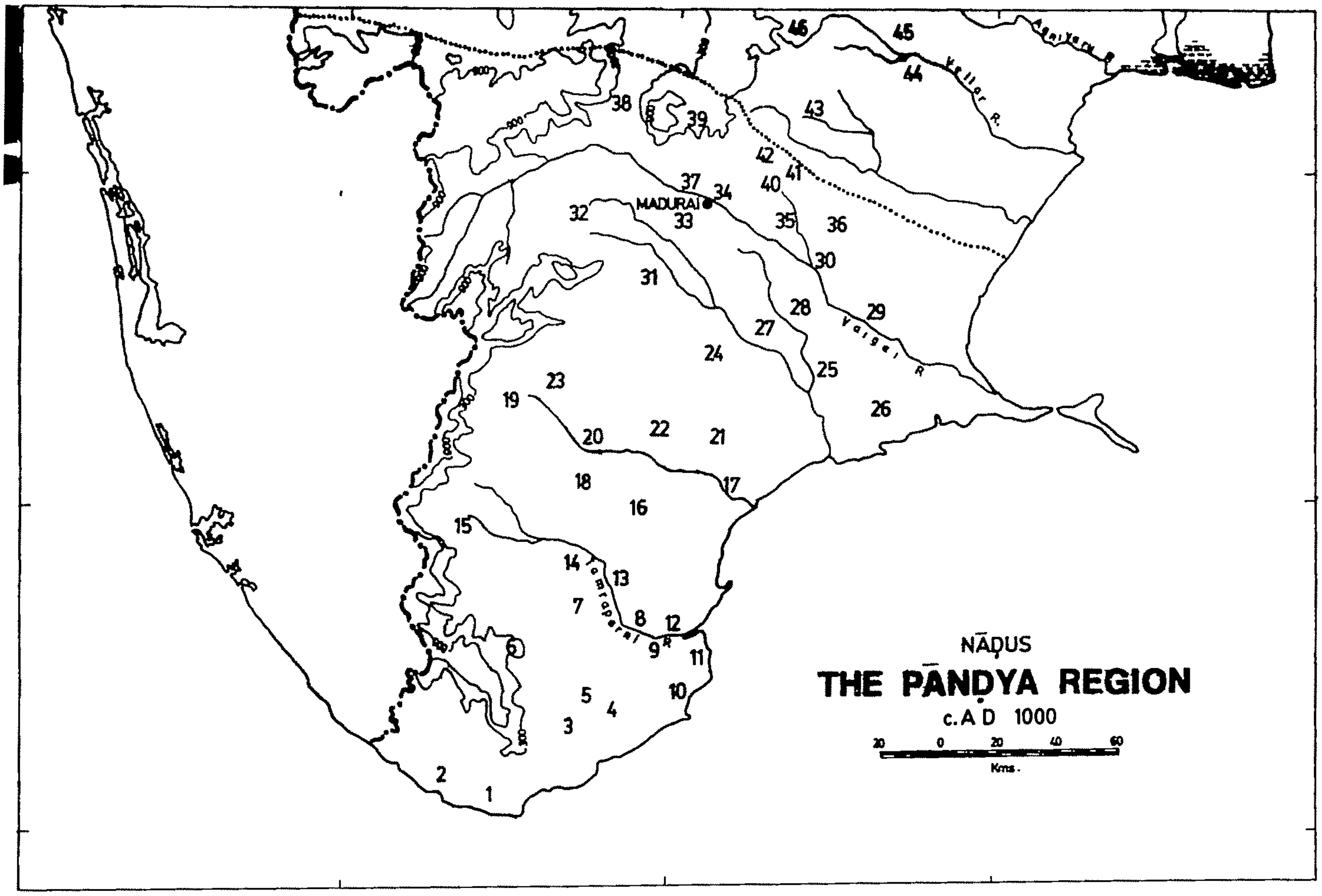

Fig. 3: The Pāṇḍya Region

them (Ten-Kavira Nāḍu) are also known. Hence *nāḍu* came to mean, even before the Cōḷa period, any settled area with a varied internal structure, both in occupation and organisation. It would be more useful to classify the *nāḍus* on these criteria and to study the changing complexion of a *nāḍu*, over a period, especially with the emergence of new *Brahmadeyas* and temple centres. All the three units, *Kōṭṭam, nāḍu* and *Kūṟṟam* pre-date the Pallava-Pāṇḍya period and yet they emerged as viable units of socio-economic importance only in relation to the new ruling elite of the 7th-9th centuries A.D.

The close relationship between irrigation and *nāḍu*-evolution has been pointed out earlier. Contextual and circumstantial evidences are the only means available to us in order to establish this relationship, particularly between the increase in irrigation facilities and the emergence of key settlements like *Brahmadeyas*. In the Kāvēri delta the embankment and canal system was the main strategy to control floods and regulate irrigation and drainage. Regions with a high degree of dependence on rainfall resorted to large reservoirs from about the 8th-9th centuries and under the Cōḷas special attention was paid to maintaining and augmenting older ones and constructing new ones as well as organizing their management. The Cōḷas also seem to have introduced the embankment and canal strategy systematically in the upper reaches of the Tamraparni river where the Tamraparni and its tributary, the Ghatana provided a fairly dependable wet zone. The expansion of Mulli Nāḍu in this zone provides an interesting case of deliberate royal choice of a region for development as a resource base. The new centres of this resource base were two *Brahmadeyas*, Rājarāja caturvedimangalam (present Mannar-koyil) and Cēravanmahādevi caturvedimangalam (Sērmādevi) founded early in the 11th century. Interestingly the two rivers are named Muḍikoṇḍacōḷappēṟāṟu and Rājarājappēṟāṟu in Cōḷa inscriptions. Several other temple centres, old and new were attached to these *Brahmadeyas* and with addition of residential quarters for the Cōḷa-Pāṇḍya viceroys it become the nucleus of urban growth in the 12th-13th centuries. Particularly important is Cēravanmahādevi in which arrangements were made by Rājendra I (1014-1044) for settling "hundreds" of families by giving them house sites (Champakalakshmi 1986b: 39).

A reorganisation of the *nāḍus* into larger revenue units called *Vaḷanāḍus* was made in the reign of Rājarāja I

(1003 A.D.) (Subbarayalu 1973: 22-24, 57-69). That it was an artificial, revenue/political unit is indicated by the fact that natural boundaries like water-courses were used and sometimes *nāḍus* which lay on either side of a river were split up under two different *Vaḷanāḍus*. The earlier location of *nāḍus* on either banks of the Kāvēri as their boundary was retained. Instances of transfer of villages from one *nāḍu* to another and separation of *Brahmadeya* and *devadāna* villages from their original *nāḍus*, perhaps from the revenue jurisdiction of the concerned *nāḍu*, and attaching them to a *Vaḷanāḍu* would also suggest that political authority could, when required, change *nāḍu* affiliations and create new revenue units. While the *Vaḷanāḍu* was introduced in the Cōḷa and Pāṇḍi Maṇḍalams systematically, in Toṇḍaimaṇḍalam it was used only occasionally, the old *Kōṭṭam* division being retained. However, in the place of *Vaḷanāḍu*, the *tan-kūṟu* or *taniyūr* as a separate revenue unit was more systematically introduced in Toṇḍaimaṇḍalam.

The *Vaḷanāḍu* nomenclature was evidently borrowed from the Pāṇḍya region, where it represented a cluster of settlements in fertile riverine areas and was a royal creation, meant to be a separate resource unit (Gurukkal 1984: 108). Rājarāja I used it initially to change the old names of conquered territories, especially those of the earlier politico-geographic areas that were chieftaincies like Kō-nāḍu which became Kēraḷāntaka Vaḷanāḍu (Pudukkottai region - a buffer) and the 8 chieftaincies between Toṇḍaimaṇḍu and Cōḷa Nāḍu, which later came to be designated together as Naḍuvil Nāḍu or maṇḍalam. Subsequently, it seems to have been used to form revenue or political units. However, this reorganization lasted only until the 13th century with several attempts at bifurcation and renaming in the hundred and odd years from Rājarāja I to Kulottunga I (1070-1118). The *Vaḷanāḍu*, however, did not seriously interfere with or change the pattern of settlements, although the *Taniyūr* in Toṇḍaimaṇḍalam and in Naḍuvil Nāḍu appear to have created a significant variation not only in settlement patterns but also in building up urban hierarchies.

In the late 10th and early 11th centuries the Cōḷas adopted the *Taniyūr* or *tan-kūṟu* nomenclature to set aside major *Brahmadeyas* and temple centres as separate revenue units, excluding them from *nāḍu* jurisdiction and attaching them to the *Vaḷanāḍu* in Cōḷa maṇḍalam. They were older settlements which were invariably founded near major irrigation works, as seen in the inscription of Parāntaka I (907-955) and other early Cōḷa rulers. Tax settlements were made by the king's government directly with such centre. (Subbarayalu 1973: 92). While the *Vaḷanāḍu* set up takes precedence in the Cōḷa core region, yet there are quite a few *Taniyūrs* like Rājadhirāja caturvedimangalam (Mannargudi) located south of one of the few tanks in the delta region. Such centres had several *piḍāgais* (hamlets) attached to them. These appear to be either pre-existing subsistence level agrarian villages or pastoral settlements or newly emerging villages. These hamlets were located in newly formed *nāḍus* called *Pērilamai nāḍus*. Perumbaṟṟappuliyūr (Chidambaram), the biggest of the *Taniyūrs* in Naḍuvil Nāḍu (South Arcot District) had 14 hamlets situated in three such *Pērilamai nāḍus*. Mannargudi had five *Pērilamai nāḍus* and one of its western *piḍāgais* was a *nagaram*, a fairly big merchant quarter called Cārigai Kōṭṭai. Vīranārāyana caturvedimangalam (Kāṭṭumannār Kōyil in South Arcot District), another *Taniyūr* of the 11th century was a *Brahmadeya* founded in the region of Parāntaka I and was located a little to the north of the Koḷḷiḍam and by the side of the huge Vīranārāyana ēri (fed by a channel from the river), one of the largest reservoirs irrigating the whole of Kār Nāḍu of that period and one which continues to be a major irrigation source in the Chidambaram taluk.

The implied connection between the *Taniyūr* and *Pērilamai nāḍu* has not been explained convincingly, for Subbarayalu equates *Pērilamaiyār* with *Vēḷāḷas* (1973: 93) and Stein curiously enough calls them middle-aged women attached to temples (1980: 162). While Stein's interpretation makes little sense, given the importance of the relationship between *Taniyūr* and *Pērilamai nāḍu*, Subbarayalu's, which is based on inscriptional evidence, is more acceptable, although he has also missed the real implication. *Pērilamai nāḍu* (*Per + ilamai + nāḍu* = the great young *nāḍu* like e.g. *Per + alam* = the greater or big salt pan could mean a young (newly formed) *nāḍu* but being important as new revenue units created by the rulers, the *Pērilamaiyār* would be *Vēḷāḷas* or peasants of these units and are so mentioned in the inscriptions. There are other *Taniyūrs* in Cōḷa Maṇḍalam dating from the 11th century, also sharing the same features to a very large extent.

It is in the *Taniyūrs* of Toṇḍaimaṇḍalam that one can recognise the close connection between *Brahmadeyas* and new irrigation works right from Pallava times and with a shift in emphasis in the Cōḷa period, when they were either newly founded or converted into *Taniyūrs*. To understand their significance, it is necessary into situate them in the context of the pastoral-cum-agrarian regions of Toṇḍaimaṇḍalam called the *Kōṭṭam*. The *Kōṭṭam* (Fig.4), of which twentyfour are traditionally assigned to the Pallava region, (Sanskrit Kōṣṭha - meaning a region distinguishable by certain specific features) had in it one or more *nāḍus*. Some of these are attested to for the first time only in the early Cōḷa and middle Cōḷa inscriptions, indicating thereby that the process of development and integration was continuous. A rough correlation of this development may also be established with the increase in references to irrigation works (tanks or lakes). While *Brahmadeya* occur in all of them and their distribution is sometimes more than one or two per *nāḍu*, the major *Brahmadeyas* designated as *tan-kūṟu* (separate revenue unit) are those whose geographical and ecological setting is of great significance. The *Brahmadeyas* when considered in

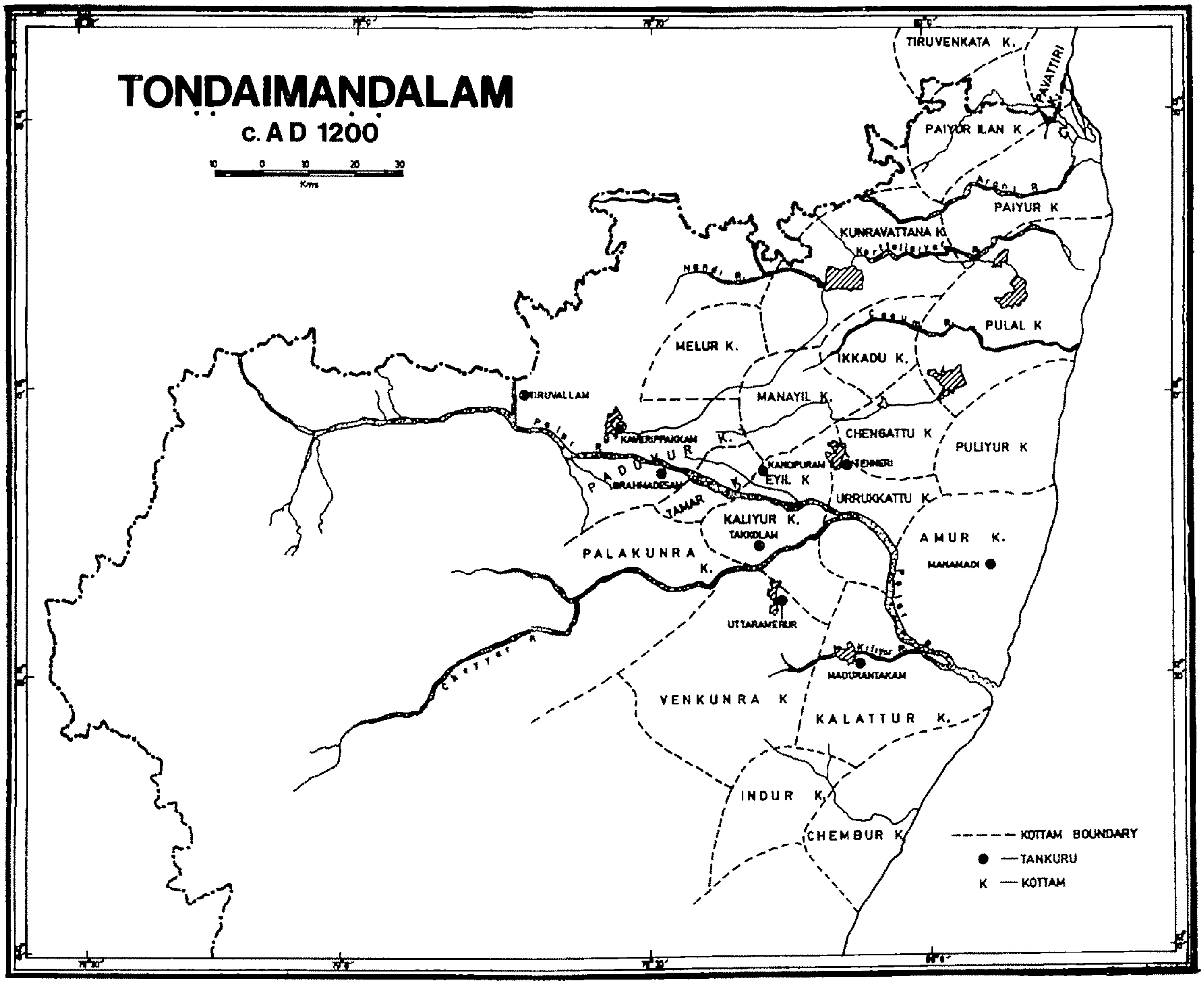

Fig. 4: Toṇḍaimaṇḍalam

their geographical and ecological setting may be seen as harbingers of advance farming methods i.e. irrigation technology and management resources and means of production. The reservoir systems in this region were initiated by the rulers and managed by local bodies like the Sabhā and Ūr. Further there is a general correspondence between the steady increase in irrigation works and the increase in the nadus between the 7th and 10th centuries under the Pallavas and early Cōḷas, particularly under Parāntaka I (907-955), when even the existing irrigation works were improved and augmented.

Distribution of Irrigation Works and Nāḍus (Toṇḍaimaṇḍalam)

	7th Cent.	8th Cent.	9th Cent.	10th Cent.	11th Cent.	Post 11th Century
Irrigation works	2+	2	16+	30	9	8
Nāḍus	3 one each in	2 one each in	17+ in	30+ in	12+ in	8+ in
Kōṭṭams	3	2	6	11	8	3

Larger-scale irrigation activity also had demographic implications, creating the pre-conditions for a future concentration was both population (Gunawardana 1981). Paddy cultivation was both highly dependent on irrigation and labour-intensive. It is also significant that maintenance by tank committees (*vāriyam*), construction of sluices (*tūmbu*) in stone, waste-weir channels, desilting and repair become important details in the 9th-10th century inscriptions. Boundaries of land, "ownership"or enjoyment rights (*Kāṇi*), nature and category of land and number of crops to be raised are invariably and increasingly recorded from this period. In Toṇḍaimaṇḍalam, it led to a restructuring of economy and indeed laid the economic foundation or resource base for Cōḷa power and a widening agricultural (and later commercial) hinterland for Kāñcīpuram. The heavy reliance on tanks or lakes in this region persists to this day and the Chingleput and North Arcot districts of Toṇḍaimaṇḍalam as well as the southern districts of the Pāṇḍya country are called "tank districts".

In Toṇḍaimaṇḍalam *tan-kūṟus* were more numerous and as in the case of Chidambaram, they represent the agglomeration of existing pastoral and agricultural and new agricultural settlements. They even brought their under jurisdiction crafts-centres (weaving centres in Toṇḍaimaṇḍalam) and salt manufacturing centres. (e.g. Uttaramērūr, a *Taniyūr*, had Tiruppulivanam, a weaving centre, attached to it). Madurāntakam had, apart from 16 hamlets, Śeyyūr on the coast in Pattana Nāḍu, a salt manufacturing centre. *Taniyūrs* increased in size and population with addition of *piḍāgais* (hamlets) and *puṟams* (revenue villages) as *devadānas* between the 10th and 12th centuries. This is also suggestive of a defining and redefining of politico-economic units within the *Kōṭṭams*. For, when older *Brahmadeyas* become *Taniyūrs*, their *nāḍu* affiliation ceased to operate and their *Kōṭṭam* location alone is mentioned as also in the case of newly founded *Taniyūrs* like Madurāntakam. The *Taniyūrs* had a district pattern of socio-political dominance and their economic and administrative functions were of a higher status than other *Brahmadeyas* and temple centres which continued to be a part of the *nāḍus*. In effect, *Taniyūr* introduced a hierarchy not only among the *Brahmadeyas* and temple centres, but also in the levels of urbanisation. This was possible because it had the capacity to widen the orbit of its economic reach, with markets developing within and a *nagaram* organised for it, (e.g. Tirukkaḷukkunram for Vānaranmahādevi caturvedimangalam). Its taxes were assessed independently and it had direct links with the king's government.

The *Taniyūr*'s link with royal and commercial centres was strengthened by communication links like roads and highways and hence it could be used as an information channel for recording royal orders, public documents, especially those relating to survey and assessment of land revenue, revision and remission of taxes on trades as well as artisan and other professional groups. The *nagaram* was the second such information channel. The internal structure of the *Taniyūr* to a large extent also reflected its functions. The *Taniyūr* invariably became multi-temple centres, sometimes covering more than 10 square miles. The distribution of the *Taniyūr* in key areas and in ten *Kōṭṭams* so far identified (Champakalakshmi 1987: 8) demonstrates their occurrence in the ratio of at least one to a *Kōṭṭam*, a feature of considerable importance in revenue administration and political linkages, as a central place. There seems to be no clear evidence of the *Taniyūr* category in the Pandya country, where *Vaḷanāḍu* was systematically introduced or even in the Kongu region, which differs from the other three sub-regions as a secondary agrarian core and is more prominent as a region of craft production, merchant enterprise and important trade routes.

Large *Brahmadeyas* as performing central place roles have already been recognised, although the significance of their links with improved irrigation facilities and expansion of agricultural regions as well as potential nuclei of urban growth processes has not been understood. (Stein 1980: 150-160). The links between larger *Brahmadeyas* and smaller ones, the transactions between *Brahmadeyas* and non-*Brahmadeyas* have been generally perceived and often discussed and yet their socio-political significance has been missed. The *Brahmadeya* itself as a marker of mature agrarian localities, and as a social and cultural marker of the mature culture of peasant groups—*nāṭṭar*—has been a constant theme in Stein's writings. Their distribution, according to him, conforms to the ecotypic conditions most favourable to Coromandel agriculture, with the most significant concentration in the riverine tracts of the Kāvēri and other rivers, especially below the 75 m contour, with a few exceptions. (Stein 1980: 151 and map). It is not a mere coincidence that the 9th-10th centuries or Early Cōḷa period uniformly witnessed this superior level of integration all over the Tamil country under Cōḷa rule, for Parāntaka's inscriptions attest to the process even in the Pāṇḍya and Kongu regions. However, after a brief breakdown in the political processes at the end of Parāntaka's reign and a recovery under Uttama Cōḷa (973-985) the processes continued into the 11th century to achieve a very high degree of integration and a distinctive socio-political culture in the macro-region.

This development is also reflected in the temple centres associated with the *bhakti* saints of the Śaiva and Vaiṣṇava, persuasions. Of the 600 Śaiva centres mentioned in the *bhakti* hymns, 363 have hymns in their praise, while 237 are just referred to. By the 11th century Cōḷa temples had come into existence in about 125 of these centres and the rest acquired temples from the time of Kulottunga I to the end of Cōḷa rule (1070-1279). Of the 108 Vaiṣṇava *bhakti* centres, 85 are in Tamil nadu and 13 in Kerala while the rest are distributed throughout other parts of India. In the 9th-10th centuries, Vaiṣṇava centres show a concentration in Toṇḍai and Pāṇḍimaṇḍalams, while Śaiva centres were more numerous in the Kāvēri delta, which had only a few Vaiṣṇava centres. From the 11th century A.D. Śaivism consolidated itself under

Cōḷa royal patronage and henceforth these centres show a major concentration in the Kāvēri valley and in the core of Toṇḍai and Pāṇḍi *nāḍus*. With the exception of Avinasi in Coimbatore district no single *bhakti* centre is known from Kongu Nāḍu. Sacred geography has been the subject of several studies, the more notable among them being those of Stein and Spencer. Their main concern, however, was to establish the theory of the ritual character of Cōḷa sovereignty through *bhakti* centres acting as royal networks ensuring the political visibility of the Cōḷas in various regions.

The above pattern would also confirm the general nature of agrarian expansion and integration in which the temple was a major institutional force. The ideology of *bhakti* under the Cōḷas would seem to have provided the most efficacious instrument in making royal power "visible" in every region through the temple. The Cōḷas gave permanence to all cult centres, replicating the temple's central role in each one of them, through a systematic renovation in stone of old shrines and the construction of new ones (Balasubramanian 1971, 1975 and 1979). The major temple projects like the Rājarājeśvara temple and Gangaikoṇḍacoliśvara were meant to be royal/ceremonial centres like Tanjāvūr and Gangaikoṇḍacōḷapuram, both of which are not *bhakti* centers but imitated the characteristics of such a centre.

By the close of the 9th century A.D. clusters of *Brahmadeya* and temple centres emerged as the foci of urban growth, showing that an initial search for urban cores among such centres would result in a better understanding of urban processes in this region. Examples of such clusters may be found in the Kāvēri delta at Kuḍamūku—Paḷaiyāṟai (Champakalakshmi 1979: 31), the residential seat of the Cōḷas and hence also a royal centre and in the Tamraparni—Ghatana Valley, in two major *Brahmadeyas* Rājarāja caturvedimangalam and Cēravarmahādevi. Caturvedimangalam and a cluster of temple centres in Mulli Nāḍu from the close of the 10th century (Champakalakshmi 1986a: 41-42), with a royal centre for the Cōḷa-Pāṇḍyas. In the evolution of an urban hierarchy, the earlier royal centres of Kāñcīpuram on the Palar and Madurai on the Vaigai as well as the Cōḷa royal centres of Uraiyūr, Kudamukku (Kumbakonam), Tanjāvūr and Gangaikoṇḍacōḷapuram, (all significantly located in the Kāvēri delta) had the pride of place as converging points of all activities, political, economic and socio-cultural. Kāñcīpuram, which originated more as a craft and commercial centre acquired the position of a capital under the Pallavas. It retained its position although as a secondary capital under the Cōḷas, and evolved as a huge multi-temple complex under the Cōḷas with a large agricultural and commercial hinterland in Toṇḍaimaṇḍalam. The role of the *Taniyūr* in this urban hierarchy has been discussed:

As a major consequence of the agrarian expansion of the 7th-9th centuries and its continuation well into Cōḷa times, and due to an increase in commercial activity, a network of market centres emerged from the 9th century onwards. These linked inland and inter-regional commerce, the latter through itinerant merchant organisations, usually described as guilds, the most important of which was the Ayyāvole Five Hundred.

Using the networks and centres model in his study of the *nagaram* as a market centre in South India in the Pallava-Cōḷa period, Hall has argued that for each agrarian locality there emerged a *nagaram* or market centre (Hall 1980). This model, derived from that of W. Skinner for rural China, suggests the existence of a system linking villages with market centres (*nagaram*), a network of such centres being linked to a *mānagaram* at the apex of a pyramid of different levels of exchange. However, there is no evidence of such a network in the Pallava period with Kāñcīpuram as the *mānagaram* at the apex for it is only after the 9th century that the network emerges and by the 12th century we hear of 24 *nagarams* for Toṇḍaimaṇḍalam, for the 24 pastoral-cum-agrarian regions called *Kōṭṭams* (Champakalakshmi 1987).

The emergence and proliferation of the *nagaram* kept pace with the increase in commercial activity under the Cōḷas. Treating the 400 years of Cōḷa rule as an undifferentiated unit, Hall (1980) has listed the *nagarams* at the end of the Cōḷa period. The pattern of *nagaram* distribution as he saw it, led Hall to recognise a maximum of one *nagaram* per *nāḍu*, the latter serving as the local marketing territory (Hall 1980: 130). While this appears to be generally true, there is evidence of more that one *nagaram* in some *nāḍus*, which may perhaps be attributed to a greater density of settlements as in the Kāvēri delta or alternatively due to newly formed *nāḍus* within a *nāḍu* as in Umbaḷa *nāḍu* (Champaklakashmi 1986a: 46-47). Eventually some *nagarams* became points of intersection for the exchange of local goods with exotic goods in which itinerant treaders participated, bringing them into a wider network of inter-regional and overseas trade, together with the *eṟivīrappaṭṭanas* or protected mercantile centres acquired by the itinerant trading corporations. The hierarchy of relationships implied in this network model cannot be overlooked and needs to be more closely examined.

The history of the *nagaram* shows that it comes into sharp focus in the reign of Parāntaka I with a partial monetisation of the economy (15 + *nagarams*) and a conspicuous increase in its number with a wide distribution in the period of the middle Cōḷas (32 + *nagarams*). The *nagarams* in this period cover not only the whole of the Cōḷa heartland but also appear in areas giving access to powerful neighbouring kingdoms and newly conquered regions e.g. South Karnataka. The pattern of distribution shows only a marginal increase in the late Cōḷa period (21 + *nagarams*) in the areas controlled by the Cōḷas, whereas with the reestablishment of Pāṇḍya power in the 13th century, *nagarams* emerged in the Pāṇḍya region.

Eṟivīrappaṭṭanas, which have been described as 'inland ports' (Hall 1980: 151) are believed to have come up only in remote and inhospitable areas. However, they seem to be more in the nature of warehouses on trade routes, converted with special royal sanction into centres with armed protection. Apart from trade routes, such centres are also occasionally located in core areas like the Tamrapami valley in Mulli *nāḍu* (Champakalakshmi 1986: 53).

From the period of Kulottunga I and Vikrama Cōḷa (1070-1133) guild activities spread to the Andhra region as far north as Visakhappattinam and the whole of the Tamil coast came to be linked to the Andhra ports. Subsequently in the 13th century a series of coastal towns emerged on the Coromandal Coast as halting stations linking a coastal route with the chief ports like Māmalāpuram, Nāgappaṭṭinam and Korkai, and the salt manufacturing centres.

Kulottunga's reign is also significant as one in which a great deal of attention was devoted to encouraging the weaving industry and as a result there emerged a large number of centres in and around Kāñcīpuram, the largest textile manufacturing centre of South India. The same period also saw the revival of earlier weaving centres, which appear to have had Jaina affiliations, either by simply reviving them as Jaina centres or by converting them into Śaiva ones, as in the region of Kāñcīpuram. A visible shift in favour of a greater degree of monetisation is also an important feature of this period (Champakalakshmi 1987). Two regions where merchant activity was heavily concentrated were the Pudukkottai-Ramanathapuram area linking the Cōḷa heartland to the Southern ports and the Salem - Coimbatore area linking Cōḷa and other regions to the Kerala coast and Karnataka. As "route areas" their location not only facilitated trade but also was a great stimulant to urbanization. Here *nagaram*'s interaction with itinerant merchant bodies was the greatest.

In the above rather rapid review of the pattern of settlements, both agrarian and urban, the emphasis has inevitably been on the *nāḍu*, *Brahmadeya* and *nagaram* centres, while the non-*Brahmadeya* centres (*ūrs*) and *paḷḷiccandam* or Jaina centres have not figured except incidentally. The reference to *bhakti* centres somewhat compensates for this lack of attention, as in most cases *bhakti* centres were not *Brahmadeyas* but played an equally important integrative role. It has, however, been implicit in our discussion of the *nāḍu* that the distribution of non-*Brahmadeya* villages in all these regions was clearly influenced by the availability of reliable irrigation sources and hence their density in the delta and riverine plains; yet, while the *Brahmadeya* has been the focus of research for long time, except for studies on major temple centres, the need for a comprehensive and intensive study of *ūr* and its spatial and chronological distribution remains unfulfilled. The lacuna is all the more striking since the ratio of *ūrs* to *Brahmadeyas* in 4 to 1 in all the regions.

There are also many opaque areas which have not been taken up for serious study like the periods of Parāntaka I (907-955) and Kullottunga I (1070-1118), when a transition or shift in the nature of settlements is recognisable from the Cōḷa records.

Another major lacuna is the lack of serious studies on the history of irrigation technology. The importance of studying irrigation technology in the early and mediaeval periods is also just beginning to be appreciated as seen in the few published works on South Indian irrigation systems. Evidence of inter-societal technology transfer between Tamil country and Sri Lanka has been pointed out by Gunawardana (1984) and this is of great significance for the Pallava-Pāṇḍya period. Gunawardana's examination of the sluice mechanisms—the cistern sluice in Sri Lanka the piston-valve sluice in Tamil country—reveals two different technological solutions to the basic problem of water regulation. The Pallavas developed the waste-weir (*Kalingu*) and sluice (*tūmbu*) in stone and taking precautions for the safety of the reservoir placed them in the bed of the reservoirs with conduits extending from the deepest level right upto the embankments. The Pāṇḍyas who constructed some large reservoirs used similar technology but with two types of valves — the *tūmbu* and *kumiḷi*.

The cistern type of sluice of Sri Lanka probably influenced irrigation works briefly in the period of Rājendra I when it was adopted at Ponnēri near Gangaikoṇḍacōḷapuram, a radical departure from other sluices of that period. However, there was a reversion to the well-known piston-sluice type not much later.

The Pallava and Pāṇḍya records provide ample evidence of the strengthening of bunds on existing lakes and tanks, as well as the construction of new ones, particularly with the use of chiselled stone in a special technique using a stringline for perfection (Gurukkal 1986: 159). There is no evidence of dams being constructed either in this or in the Cōḷa period, the earliest reference to a stone dam being that of a 12th century Pāṇḍya record on the Vaigai. The Grand Anicut (*Kallaṇai*) at Tiruchirapalli, attributed to Karikāla, on the basis of legends, has now on the basis of structural considerations been dated to the mediaeval period i.e. 14th-15th centuries. It is rather surprising considering the early use of stone in sluices and in grand temple projects, that the idea should never have occurred to the Cōḷas to control and regulate the flood waters of the Kāvēri from its delta head i.e. at the site of the *Kallaṇai*. The implications of this are undoubtedly political and are important for understanding the state system under the Cōḷas.

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Early Historical Settlement in the Deccan: An Ecological Perspective

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A striking feature of the early Historic period c. 500 B.C. - 400 A.D. is the southwestward shift of the core region from Magadha and the middle Ganga valley, towards the Deccan. Under the Kusānas, the focus was on the northwestern axis from Taxila to Mathura, whereas under the Sātavāhanās the epicentre was the Western Deccan with the earliest records of the dynasty inscribed at Nasik. An obvious question that needs an answer is the reason for this shift and the extent to which it can be explained by an ecological approach. Central to this perspective is the nature of man-environment interaction, "since it is a fundamental of any ecological approach that the impact of man on his environment cannot be divorced from the impact of the environment on him. And the second and equally fundamental point is that we are interested in man-man interactions, since the way in which the activities in that society are patterned determines both its nature and the way it exploits the environment" (Renfrew 1982: 108).

The emphasis in this paper shall be on the Deccan in the early Historic period. After a brief survey of the geographic features of the region, we shall trace the beginnings of habitation starting from the 5th century B.C. and extending into the Satavahana period. From numismatic, inscriptional and archaeological data, the nucleii of settlements shall be demarcated and wherever possible these then related to their hinterlands.

The Deccan plateau may be described as a great tabular block with a general slope to the east. Unlike the continuous expanse of the Indo-Gangetic plain in the north, the Deccan is characterised by the scattered and isolated pockets of fertile tracts surrounded by forested uplands, the home of small and often predatory populations. The fertile pockets are generally restricted to the narrow river valleys and the deltas along the eastern sea-board and as a result the surplus available for maintaining a complex political hierarchy is also limited.

Within the Peninsula, several micro-regions may be demarcated the eastern littoral forming a strong contrast to the western. The former is much wider than the Konkan and Malabar coasts and is better suited to the cultivation of rice, through irrigation is important, particularly tank irrigation, in much of Andhra Pradesh (Spate and Learmonth 1967:43). Geologically and climatically the western Deccan forms a unified region within the Peninsula. Agriculturally also the western Deccan is different from the Ganga valley owing to the greater importance of cash crops and the insignificance of both rice and irrigation. The topography has influenced the development of well-defined routes which follow the passes along the hill ranges. The continued importance of these is brought out by the fact that several railway tracks at present follow the ancient routes.

The undulating terrain and the non-perennial nature of the Peninsular rivers makes them unsuitable for navigation or for gaining access to the interior of the Peninsula. This has increased the importance of the sea for communication and traffic is either coastal or else overland along the passes. As they are entirely dependent on monsoon rainfall the Peninsular rivers are almost dry in the summer and of very little use for irrigation.

What the Peninsula lacks in terms of agricultural productivity it more than makes up for in terms of mineral resources. The Kolar district of Karnataka is known for its gold deposits and numerous ancient gold mines have also been found in various parts of the Raichur doab. There are two extensive diamond yielding tracts in the Peninsula - the Krishna-Godavari region and the vicinity of Cuddapah on the river Pennar. The Deccan Trap forms the chief source of semi-precious stones, prominent among which are agate, carnelian and other forms of chalcedony. Beryl is reported from Padiyur mines in Coimbatore district and the Gulf of Mannar was also the largest supplier of Oriental pearls till the beginning of the century.

Peninsular India first finds mention as *Dakṣiṇāpatha* in the *Aitareya Brāhmaṇa* (VII. 18) dated to the pre-Buddhist period. The text describes the southern frontiers as the place to which the fifty older sons of Visvamitra migrated on being

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superseded to accession to the throne and it is from these that the *dasyu* tribes were descended. The migration myth has been frequently used to provide legitimacy to and assimilation of tribal groups within the Brahmanical fold. In contrast to these generalised references, Pali texts and the *Arthaśāstra* show a greater familiarity with the resources of the Deccan, in particular the semi-precious stones, pearls and diamonds (Lad 1978: 293).

The archaeological data indicate that in the middle of the first millennium B.C. the cultural matrix across the Deccan presented a wide-range of iron-using communities. The transition from the late Jorwe Chalcolithic phase of Inamgaon dated to 900-800 B.C. to the early Iron Age occupation is till not clear. Several sites such as Maheshwar-Navdatoli (Period IV) on the Narmada and Prakash and Bahal on the Tapi provide evidence of the latter phase. Iron appears at the beginning of this period and continues alongside the Black-and-Red Ware. A feature common to many of these sites is the fact that they are located at river-crossings. This observation is significant, because as stated earlier, the rivers of the Deccan are not easily navigable and can be crossed only at specific points which then determine land-routes.

The settlement pattern suggests the presence of both land and costal routes. At Bharuch on the west coast, the ancient settlement came into existence in the latter half of the first millennium B.C. (*IAR* 1958-59: 69; *IAR* 1959-60: 19). Another exchange centre further down the west coast may have been Banavasi, traditionally associated with the spread of Buddhism under the Mauryas. At Vadgaon Madhavpur in Belgaum district a large hoard of punch-marked coins was found (Sundara, 1981) and occupation has been dated from the third century B.C. onwards at this site, though further details are not available. Along the east coast, an important halting point of the looping coastal route from Tamralipti in the Bengal delta was the lower Krishna valley. At Dharanikota, on the Krishna, the earliest structural activity was marked by the construction of a wharf raised on posts at right angles to the navigation channel (*IAR* 1963-64: 2; *IAR* 1964-65: 2) and two radiocarbon dates of 475 and 390 B.P. are available (*IAR* 1965-66: 86).

In the other regions of the Deccan, there was a spread of Megalithic communities. Radiocarbon dates from Hallur in Karnataka suggests the opening of the Megalithic period may be as early as 1150-1030 B.C. Another region which indicates fairly early beginnings is the Vidarbha region of Maharashtra where hundreds of stone circles have been found. A radiocarbon date of 750 B.C. is available from the earliest levels of Baghimohari suggesting that the beginning of the settlement may go back a further century or more (Deo n.d.). The inhabited regions in the Megalithic period extended from Vidarbha, past the dense cluster of sites in Karimnagar district of the middle Godavari valley (Krishna Sastry 1983) to the Medak and Nalgonda districts of Andhra and to the lower Krishna valley. As elsewhere, Megalithic communities show a preference for areas rich in mineral resources. There is a concentration of sites in southwest Andhra Pradesh in the vicinity of iron deposits and gold-bearing Dharwar schist belts (Chatterjee 1976: 216). The Kolar district of Karnataka known for its gold bearing deposits is also replete with Megalithic monuments. Similarly there is a large Megalithic settlement at Hire-Benkal in the Tungabhadra valley (Gangavati-Hospet area) known for its iron ore reserves. The expansion of Megalithic sites into the fertile flood plains of the Krishna river indicates perhaps a diversification of the resource base and in addition to the exploitation of the mineral wealth, a greater reliance on agriculture. Access to timber and mineral resources like gold, diamonds and semi-precious stones must have been the prime attraction for Mauryan interest in the Deccan and the location of their inscriptions indicate the major routes. A concentration of Mauryan epigraphs is well known in the Mysore plateau and along the coasts - at Sopara on the west coast and at Dhauli, Jaugada and Amaravati on the east coast. These mention Suvarnagiri as Asoka's southernmost provincial headquarters administered by a royal prince (Sircar 1975). Archaeologically, however, there is no evidence of a Mauryan settlement in Karnataka and excavations at Brahmagiri and Maski have failed to reveal what may be termed a Mauryan phase. This absence may be explained by the way the Mauryan economy was structured. The prime concern of the state was with extracting revenue from existing resources rather than with creating new resource bases or reorganising existing ones. Thus in areas of interaction, such as Karnataka, the organisation of labour prevalent in the Megalithic period may have been adapted to suit imperial requirements (Thapar 1987: 29). In the lower Krishna valley epigraphic and numismatic data point to an involvement of local groups interacting with the Mauryas. Of the 235 varieties of punch-marked coins found in a hoard at Amaravati, 48 were exclusive to the hoard and likely to have been minted in the Deccan (Gupta 1963: 2). Similarly inscribed granite railing pillars belonging to the earliest phase of the stupa at Amaravati record donations by the local populace (Ghosh 1979). Contact between the southern province and the epicentre of the Mauryan empire in the north was maintained through several possible routes both coastal and overland. There were several points of interaction along these routes and what is interesting is the very different trajectories of development and social change that these underwent.

To focus on the Western Deccan first: characteristic Mauryan Northern Black Polished Ware and punch-marked coins have been found at several sites on the overland route connecting the lower Krishna valley with the port of Bharuch on the west coast and Ujjain in central India. This was in addition to the coastal routes both along the west and east coasts referred to earlier. It would seem that the importance of the overland route continued in the post-Mauryan period and a local coin series has been found at several sites such as Maheshwar, Nasik and Nevasa (Narain 1968: 89-101). This is comprised of uninscribed die-struck and cast copper coins; the former being dated to the third-second centuries B.C. on the basis of the excavations at Bhokardan. These were followed by a series of inscribed copper coins in the 2nd century B.C. bearing the names of cities or urban centres. In spite of the inter-connection of symbols, each city issued its distinct coins and in central India these include the coins of Vidisha, Eran, Ujjain and Tripuri (Lahiri 1976: 35-54). The only issues known in Central India and Deccan come from Mahismati or Maheshwar and a single coin from Tagara or Ter (Gupta 1971: 37-40) respectively. These suggest that in the post-Mauryan period, power was held by some form of an urban corporate body also known by the term '*nigama*'. The *nigama* of Karnataka identified with Karad is mentioned in the 2nd century B.C. inscriptions at Bharhut and to the list may also be added the settlements of Bhojakataka, Nasik, Benakataka, and Bhogavardhana or Bhokardan (Lueders 1963: A 23-24: A 46; A 49a; A 51 respectively). A common denominator of all these early settlements is their location along an overland route and the absence of a Megalithic substratum.

Many of these centres generated a surplus capable of supporting Buddhist monastic establishments. Structural remains of brick-built stupas have been unearthed at Pauni in Vidarbha (Deo and Joshi 1972: 117); at the site of Maheshwar (Sankalia *et al.* 1958: 21) and at Kasrawad, 5 km from Maheshwar. Possibly the earliest rock-cut caves on the west coast were those of Thanale and Kondivate. Some silver punch-marked coins found at Thanale cave are dated to the 2nd - 1st centuries B.C. (*IAR* 1979-80: 103) while a *caitya* and a few *vihāras* at Kondivate were excavated around 100 B.C. (Dehejia 1972:152-3).

Numismatic evidence indicates that development in the post-Mauryan period was very different in the eastern Deccan and in Karnataka. Ecologically these two regions present a strong contrast to the western Deccan and this has been discussed at the beginning of the paper. Culturally also there was a marked presence of Megalithic settlements in these areas. It was perhaps as a result of a combination of these factors that a somewhat amorphous political control developed in the post-Mauryan period.

In the Vidarbha region of Maharashtra and the Karimnagar district of Andhra Pradesh, coins of Samagopa, Gobhadra, Satyabhadra and Damabhadra have been found (Parabrahma Sastry 1978, 1979). Inscribed punch-marked coins of the last named chief have also been reported from Nandner in Central India. The names *Kamvaya* and *Narana* have been read on some copper coins from Kotalingala (Sastri, 1982: 4). Coins issued by these rulers are not known elsewhere in the Deccan, nor is their identification with Sunga kings accepted (Gupta 1978). On palaeographic and typological grounds the coins dated to the pre-Satavahana period are attributed to the local chiefs of the Karimnagar and Vidarbha regions (Gupta 1978; Sastri 1982). Other groups of chieftains in the region were perhaps the *mahāraṭhis* and the *mahātalavāras*. In the pre-Satavahana levels at Polakonda a potin coin was found with the legend *mahātalavārasa Vijasamikasa Sevā Sabhā* and the same legend also occurs on a terracotta seal from Peddabankur (Krishna Sastry 1983: 129) while a *mahāraṭhis* Vidarbha has the three-arched hill symbol on the obverse (Deo and Chatte 1973: 236).

Excavations at Brahmapuri in the western part of the town of Kolhapur in the upper Krishna valley indicate that the site was first occupied in the 2nd century B.C. (Sankalia *et al.* 1952). The earliest layers at the site yielded inscribed coins of copper and lead belonging to the Kura Kings - *mahāraṭhi* Vilivayakura and *mahāraṭhi* Kura at Vadgaon-Madhavpur (*IAR*: 1975-76: 19) in the adjacent district of Belgaum dated to the mid-first to early third century A.D. would suggest that the Kura kings continued to rule over certain parts of Karnataka while the Satavahanas held sway in the western Deccan.

Uninscribed coins together with inscribed issues attributed to Sadakana Kalālaya *mahāraṭhi* and Sadakana Chatakanha *mahāraṭhi* have long been known from the excavations at Chandravalli in Chitradurg district in Karnataka (Wheeler 1947-48). Here again the coins of the Sadakana rulers occur in earlier layers as compared to those of the Satavahanas; the latter being represented by one coin of Puḷamāvi and two of Yanña Sātakarṇi (Wheeler 1947-48). A seal found in the 1935-36 excavations at Maski bears the fragmentary legend *mahāraṭhisa* (*Annual Report of the Archaeological Department of the Nizam's Dominion 1935-36: 22-4*).

Inscriptional evidence from Amaravati supports the presence of local groups wielding political authority in the 2nd century B.C. Senagopa Mudukutala (Lueders 1912: No. 1266) may have been a local chieftain on whom the title *senagopa* had been bestowed under the Mauryas. Similarly the local affiliation of *senāpati* Dharaka is evident from his clan name *pakataka* (Ghosh 1979: No. 7a). The *pakatakas* are known as Vakatakas in 3rd century A.D. inscriptions (*Epigraphia Indica* XV: No. 27). Another epigraph from Vaddamanu about 10 km. from Amaravati refers to a *raino Damaka* (*IAR*: 1981-82: 1) and a second *rāja* Khubiraka, chief of the Simha *gothi* is referred to at Bhattiprolu (Buehler 1894:323). This evidence is corroborated by numismatic data. A series of early Sada coins have been found at Vaddamanu and are also known from Amaravati and Dharanikota, though the identity of the issuing ruler has not yet been established (Gupta 1986).

In addition to the clan, the *nigama* also played a significant role in the lower Krishna valley. A reference has already been made to the Bhattiprolu inscriptions which refer to *rāja* Khubiraka, chief of the Simha *gothi*. Another record lists twenty members of a *nigama* (Buehler 1894). Both the *gothi* and the *nigama* existed at Dhanyakataka and one of the reliefs on the stele from the stupa site at Amaravati refers to the *gothi* called Vamda while another was the gift of Dhamnakadaka *nigama* (Ghosh *et al.* 1964-65: 175).

This survey leads to the conclusion that with the decline of the Mauryan empire, political authority became localised in the Deccan, but these ruling groups could not lay claim to large territorial entities which could be best described as 'localities' (Chattopadhyaya 1987:728). A distinction in the nature of the authority could be made between that prevailing in the northern Deccan as contrasted to the rest of the region. In the northern Deccan power was wielded by corporate bodies associated with exchange centres, whereas elsewhere in the Deccan clan-chiefs were in a dominant position. In the fertile lower Krishna valley which lies on the eastern coastal route, the *rāja* or chief was associated with the *goṣṭhi.*

Though the local origins of the Satavahana dynasty are indisputable and have been discussed elsewhere (Ray 1986) it is not quite clear how they relate to the cultural milieu described above. What is evident from Satavahana inscriptions is their close marital alliances with the *mahāraṭhis* and the *mahābhojas*. With the rise of the Satavahanas in the 1st century B.C. the epicentre shifted to the region around Nasik which was the site of the first epigraph of the dynasty. A factor of crucial importance was an acceleration of demand for spices, woods and textiles from Mediterranean markets and increased maritime trade. This is reflected in the Satavahana settlement pattern which sows the establishment of a series of ports along the west coast. These ports were connected through the passes in the Sahyadri Range to the fertile upper reaches of the major rivers such as the Godavari, Bhima and Krishna (Ray 1986). The phenomenal increase inn maritime traffic and the surplus it generated is evident from the fact that occupation at this time spread to the agriculturally unproductive South Konkan coast and Buddhist monastic establishments are a consistent feature in the vicinity of ports. As expected, the largest settlement on the west coast was centred in the Ulhas basin with the market towns of Sopara and Kalyan situated in close proximity to each other. These were connected through the Naneghat to the inland centre of Junnar situated in the fertile Ghod valley. The surplus potential of the settlements in the region can be estimated from the fact that nearly 184 Buddhist caves were located in the neighbouring hills (Jadhav 1981: 184). Rock-cutting activity at these sites extended from the beginning of the 1st century B.C. to the 2nd century A.D. (Dehejia 1972) and one of the reasons for the cessation of activity may have been the silting up of the port at Sopara.

Satavahana inscriptions refer to the *āhāra* (possibly food-producting eco-zone) as a territorial unit. A 1st century B.C. seal from Peddabankur, Karimnagar district, mentions the Vijayapurāhāraka (Krishna Sastry 1983: 186). Govardhana-ahara has been identified with the area around Nasik, while Soparakāhāra may be placed in the North Konkan coast. Māmalāhāra of a Karle inscription was represented by Maval, the hilly portions of the Pune and Satara districts and the Satavahannihara of the Myakadoni inscriptions comprised the Bellary district of Karnataka. The Kṣatrapa inscription of Nāhapāṇa refers to Kapurāhāra which has been identified with the Old Baroda State.

By the late 1st - early 2nd centuries A.D. Satavahana settlements in the western Deccan seem to be expanding into Andhra Pradesh and Karnataka. Several reasons may be suggested for the shift. The first was the conflict with the Kṣatrapas pushing into the Northern Deccan from Gujarat. Secondly it may have been an attempt to control directly the resources of the lower Krishna valley. Finally, it may be linked to the expansion of maritime traffic which increasingly touched the ports of the Andhra coast from the second century A.D. onwards. In the early centuries A.D. the number of sites in Karimnagar district multiplied enormously with an early Historic site being reported from almost every alternate village. The largest site in the cluster was that of Kotalingala extending over 50 hectares at the confluence of the rivers Peddavagu and Godavari. From the remains at Dhulikatta it would seem that by the 3rd century A.D. the peak period of prosperity was over and the nature of the habitation changed from brick structures to mud-built houses (Gururaja Rao 1978: 66).

It is early in the 2nd century A.D. that for the first time a Satavahana epigraph - that of Puḷumāvi - occurs outside the limits of the western Deccan at Amaravati (Burgess 1882: 100). Vaṣiṣṭhīputra Puḷumāvi was also the first Satavahana ruler to issue bilingual coins (Gokhale 1978: 14) the dialect on the reverse being identified as a Dravidian dialect. A distribution map of Satavahana coinage shows a concentration in thee lower Krishna and Godavari valleys, especially during the later Satavahanas (Sarma 1980: map XX).

The excavations at Brahmapuri (Kolhapur) and Chandravalli have yielded Satavahana coins in later levels, while those of the local rulers occur in earlier phases corroborating the evidence for Satavahana expansion. An important site on the banks of the Bhima in Gulbarga district is Sannatti. Exploration has revealed a stupa, a fortified settlement of typical Satavahana brick and several inscriptions (*IAR* 1966-67; Nagaraja Rao 1985).

By the 3rd century A.D. the volume of trade had been reduced but it would be erroneous to describe it as a cessation of maritime contacts. The evidence from the western Deccan indicates a transition to a late Hīnayāna phase at Buddhist centres like Junnar, Kanheri, Karad, Kuda, Mahad and Shelarwadi (Dhavalikar 1984). In the South Konkan there was a fresh impetus to rock-cutting activity in the late 3rd-early 4th century A.D. when caves at Khed, Chiplun and Panhale (Kaji) were excavated (Deshpande 1986).

Another emerging factor at this time was the maritime trade with Southeast Asia, especially the Malay Peninsula and through the Burmese coast with Central Thailand. On the Indian coast, the focus seems to have been the Andhra region.

Scores of sites dated to the 3rd-4th centuries A.D. - both Buddhist and secular - have been located along the Andhra coast from Salihundam to Ramatirtham, with a concentration in the Krishna delta. The most important of these was Nagarjunakonda.

The survey shows the various stands that are reflected in the settlement pattern. On the one hand, geographical features and agricultural productivity are linked to the location of settlements. At the same time the economic base determined routes and shifts in the core region. In the Deccan particularly, the expansion of settlements depended on a successful mix of agriculture and trade with religious establishments providing cohesion in newly settled areas. It was this complexity of factors that led to the prosperity of different ecological niches in the Deccan.

Acknowledgement

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Ecology, Population Distribution and Settlement Pattern in Mughal India

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A basic shift in ecology occurs in all agricultural societies whenever the plough makes inroads into the forest or grassland. There are other man-made factors too which influence the domain of nature, such as timber-cutting and overgrazing; but it is the limits of the agricultural zone which constitute the main frontier between the territories of nature and of man. The ecological change since 1600 A.D. can therefore be grasped, in general terms at least, by tracing the extent of cultivation at that time, with a view to comparing it with what it has come to be in more recent times.

An important statistical record exists for computing the extent of cultivated land around c.1600. The *Ain-i-Akbari*, the gazetteer of Akbar's Empire compiled by his minister Abu'l Fazl, gives us measured area (*arazi*) statistics for the whole of Northern India (except some parts of Bihar, Bengal, Sind, and Kashmir). Moreland (1930: 20-22) and Habib (1963: 12-15) made use of these figures to work out the extent of cultivation in Akbar's time, and I have tried to go over the same ground again (Moosvi 1987: 39-71).

The estimates worked out by me therefore have been for the cultivated area in only three regions of Akbar's Empire[1]: (a) U.P., comprising the Mughal *subas* of Awadh, Allahabad, most of Agra and parts of Delhi, (b)Gujarat, excluding Kutch and Saurashtra (the Mughal *suba* and the present state of Gujarat had practically identical boundaries) and (c)the British province of the Panjab, consisting of the Mughal *suba* of Delhi west of the Yamuna, provinces of Lahore and Multan, excluding the *sarkar* of Bhakkar [See Fig.1 (a), (b) and (c)].

(a) Within the large tract corresponding to U.P. the proportion of the total area under cultivation in c.1600 varied greatly from one part to another. In the revenue-circle of Agra, cultivation was almost as high as in 1909-10; in the lower Yamuna Doab and North-West U.P., it was above 80% of what it was in 1900-10. On the other hand, the area between the Ghaghara and the Ganga was much less densely cultivated, the area under cultivation amounting, in 1600, to 40 to 60% of that in 1909-10. In the extreme northeastern block of Gorakhpur, cultivation was so sparse as to cover less than 10% of the sown area in 1909-10.

(b) In Gujarat some parts were already highly cultivated. In Baroda, Surat and Nadaut the extent of cultivated land reached almost 90% of what it was in 1903-4. In Ahmedabad it was 68% but in Patan it was only around 43%. The cultivated area was the lowest in the *sarkars* of Champaner and Godhra (28% and 37% respectively.).

(c) The extent of cultivation in East Panjab, that is, the Mughal *sarkars* of Rewari, Hissar Firuza, Sirhind and Delhi west of the Yamuna, was about 45% and in Multan a little over a quarter of the cultivated area in 1909-10. In West Panjab, comprising all the territory west of the Sutlej, cultivation in c.1600 was nearly 40% of what it was in 1909-10.

If one can generalize from these samples covering around a third of the total area of Akbar's Empire, the extent of cultivation in Mughal India might be put at 50 to 55% of what it was in the opening decade of the 20th century.
A doubling of the extent of cultivation during the three centuries since 1600 must have meant an immense retreat of forest and wasteland. The retreat, however, has been on varying scales in particular zones or localities. The middle Doab (in Western U.P.) was already practically fully cultivated by c.1600. The extensive stretches of forest, which were once found here — in the 13th century, a traveller faced the danger of encountering tigers in the area — had by now

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The maps accompanying this paper are drawn by Faiz Habib and Zahoor A. Khan.

[1] The *Ain-Akbari* also gives measured area figures for parts of Rajasthan and Madhya Pradesh but as these are incomplete, a reliable estimate is not possible.

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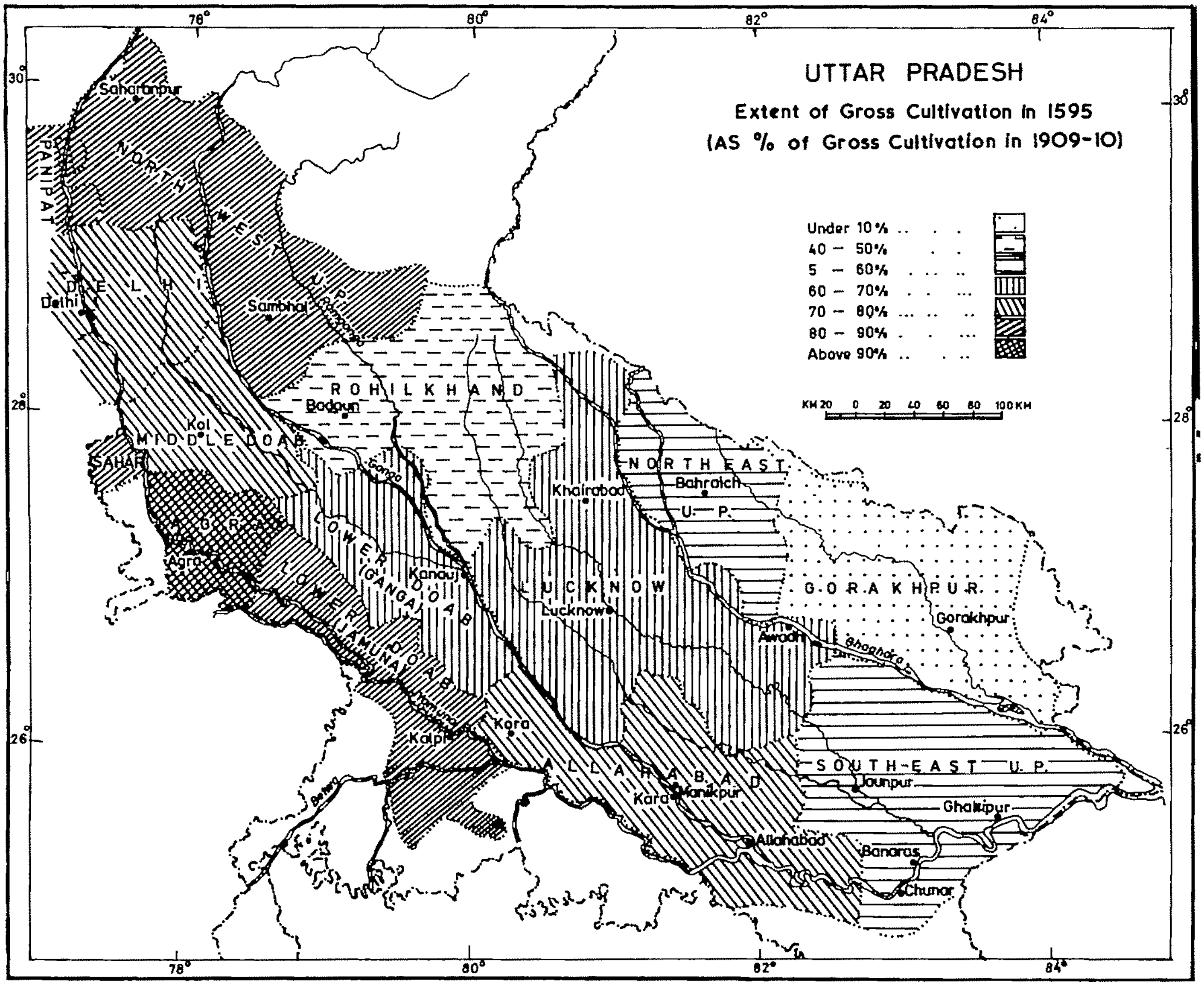


Fig. 1a: Uttar Pradesh: Extent of Gross Cultivation in 1595 (As % of Gross Cultivation in 1909-10)

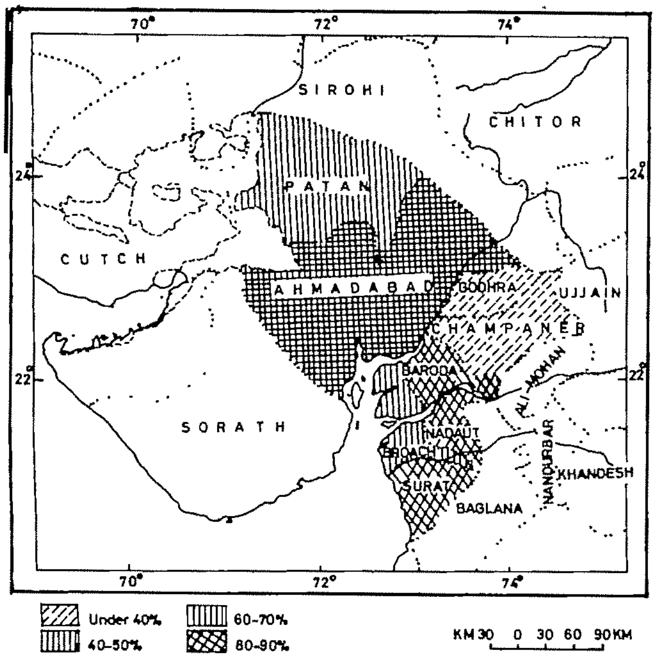


Fig. 1b: Gujarat: Extent of Gross Cultivation in 1595 (As % of Gross Cultivation in 1903-4)

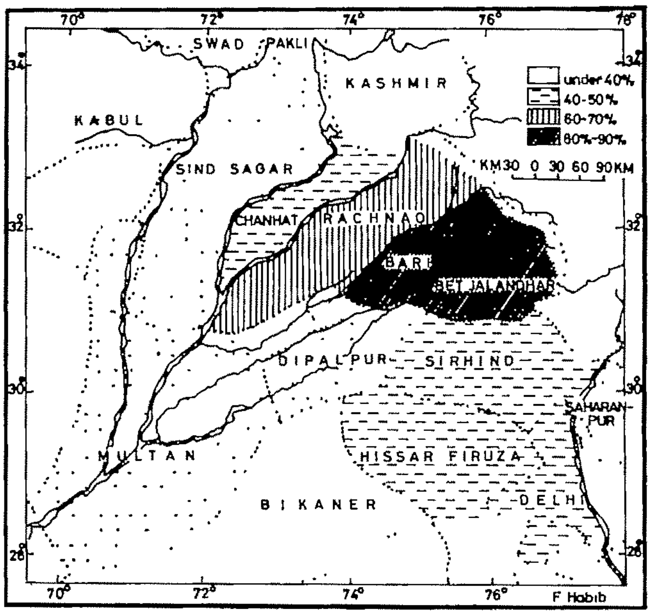


Fig. 1c: Panjab: Extent of Gross Cultivation in 1595 (As % of Gross Cultivation in 1909-10)

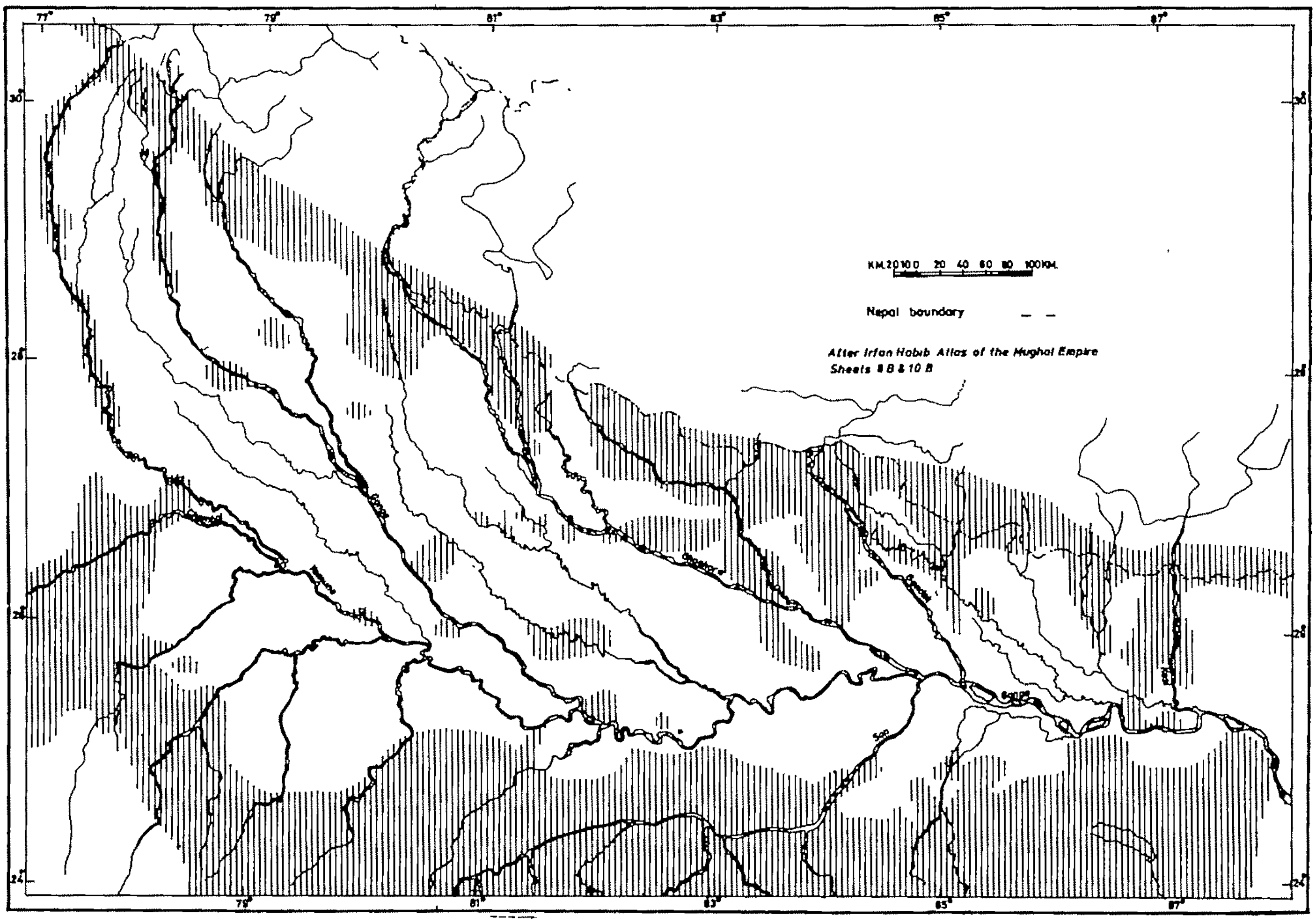
been cleared (Raychaudhuri and Habib 1982). Pelsaert particularly notices the lack of trees in the countryside, the surest sign of forest clearance (Pelsaert 1626: 48).

The very large *sarkars* of Gorakhpur (East U.P.) were 'full of forest' in the middle of the 17th century (Tavernier 1647: 20). Here forests large enough to harbour wild elephants are recorded down to the beginning of the 19th century (Ghulam Hazarat 1810). The increase of cultivation by over tenfold in this region, as indicated by our area statistics, has been almost entirely at the expense of these forests.

If in the Gangetic basin the advance of the plough has been at the expense of forest, towards the west it has been largely at the expense of desert, grassland and scrub.

In the Haryana block of British Panjab the extent of cultivation was two-fifths of what it was in 1909-10. But there are no forests here beyond the thin strip along the Yamuna and the equally thin sub-montane tract. In the 16th-17th centuries imperial hunting grounds, where cheetahs were caught, were located in the sarkars of Hissar Firuza and Sirhind. The *A'in* notes the existence of desert in the southwestern part of *sarkar* Hissar Firuza (see Abu'l Fazl 1595-96: 257) as is indeed the case today as well. In this region the introduction of canal irrigation in the last quarter of the 19th century helped to extend cultivation over dry grassland. But the impact of the introduction of canal irrigation has been more spectacular in Western Panjab. In the *sarkars* of Multan and Dipalpur, cultivation in c.1600 comprised only a quarter of the cultivated area at the beginning of the present century. A large part of the area was covered by extensive dryland. But there was also jungle like the Lakhi jungle in *sarkar* Dipalpur, created by flood-channels of the Beas and Sutlej rivers (Sujan-Rai 1695-96: 63). The Lakhi jungle has now disappeared, and much dry wasteland (previously serving for pastures) brought under cultivation with water from the canals. Some areas, e.g. in Sind, have been cultivated by directly reclaiming tracts from the Thar Desert.

The retreat of the forest in the face of the peasant's plough can also be established for different areas from direct contemporary evidence about forests where they no longer exist. Abu'l Fazl in his description of the geography of the provinces of Akbar's Empire, gives an account of the forests as well. Other Mughal historians often mention forests in their accounts of the topography of the regions where Mughal arms penetrated. European travellers too have left records of forests they had to pass through on their journeys. Much of this information has been collected and represented in the notes and maps of the *Atlas of the Mughal Empire* (Habib 1982). Sheets 8B, 10B and 11B of the *Atlas* show these forests in greater detail, presumably because for this region (U.P., Bihar and Bengal), James Rennel's mapping of forests is available as a kind of floor-line. By about 1780 Rennel prepared maps of the Gangetic Basin on the basis of what later official mappers would have called 'reconnaissance surveys'; and showed forests as they then existed (Rennel 1781).

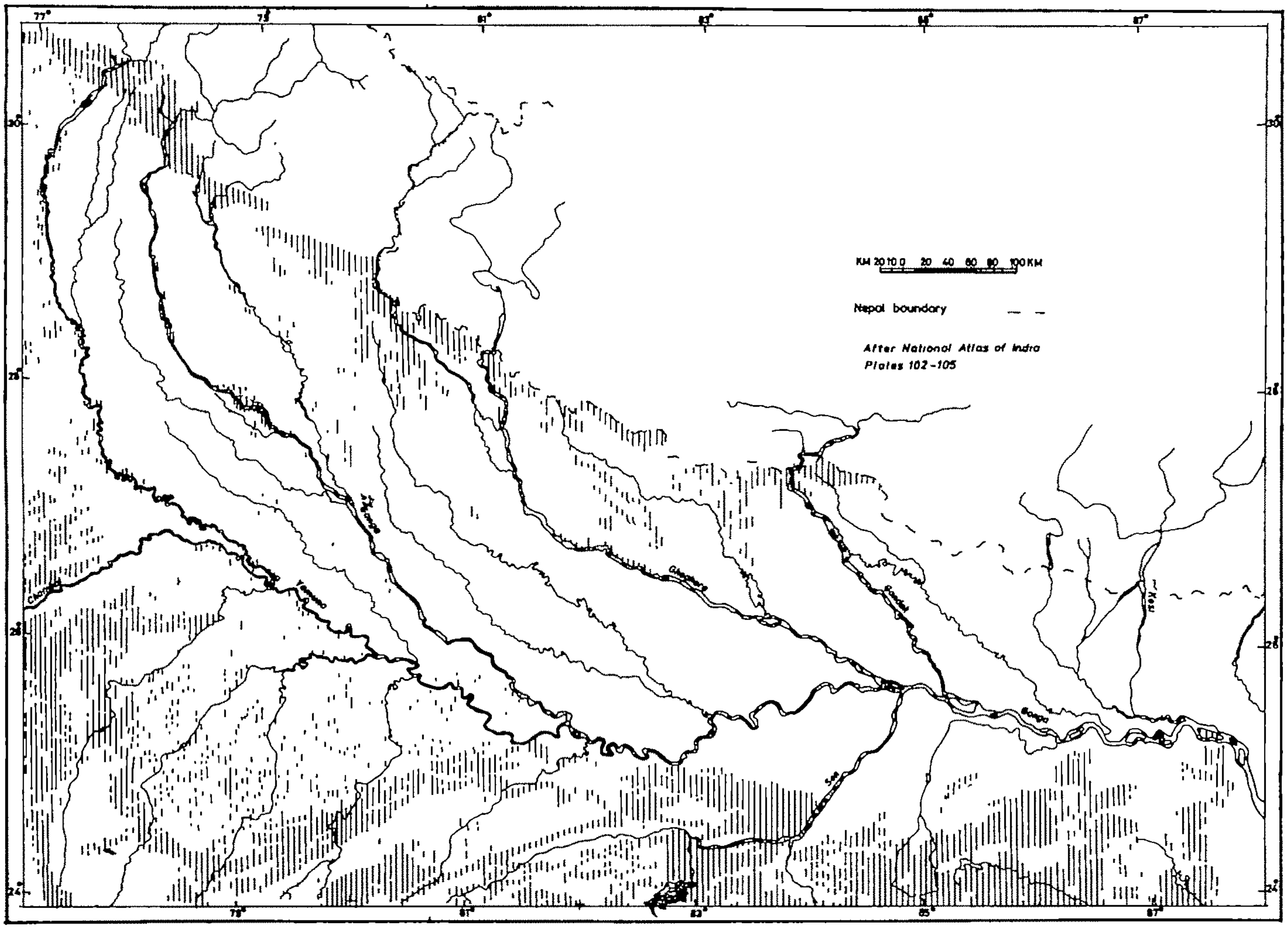


After Irfan Habib Atlas of the Mughal Empire Sheets 8 B & 10 B

Fig. 2: Upper & Middle Gangetic Basin: Forests & Scrub (Excluding Himalayan Forests) 17th Century

On the basis of sheets 8B and 10B of the *Atlas* of the Mughal Empire, I have prepared a map of forests, c.1600, in the upper and middle Gangetic Basins (Fig.2). This map offers some additions for southern Awadh based on Butter's report on the topography of the area, (Butter 1839: 4-9, 116-125). He reports 'an immense forest' in Pratapgarh and another of three miles diameter in Salon (U.P.). Butter distinguishes two types of forests in the region: one occupying lowlands annually overflowed by the Ganga and Deoha, which could not be reclaimed for cultivation, such forests being mainly in Bainswara. The other type of forests were more numerous but more vulnerable to encroachments. The land being very fertile these forests, usually interspersed with stretches of cultivation, were already fast disappearing. A large forest (20 by 8 miles), in the vicinity of Manikpur, had by then been almost entirely cleared within the short span of four years between 1833 and 1837. However, there were still some 'silvan' stretches near Niwardipur, Faizabad, Pali and Rudauli that were deliberately preserved either for pasturage or as possible places for refuge by the zamindars. These forests were mostly dry and therefore free of wild elephants.

The Map (Fig.3) is based on the *National Atlas of India* (sheets 102-105) and shows the area covered by forest and scrub in the same region uptill 1951. Both Maps II and III omit depiction of forests in the Himalayas and north of the India-Nepal frontier. A comparison of Maps (Figs. 2 and 3) shows that the *Tarai* forest, which was very broad and continuous in the 17th century right from Purnea in Bihar to Bahraich in Awadh (U.P.) disappeared in the east (south of the India-Nepal frontier) while the remaining stretch of *Tarai* now survives in broken fragments and strips. In the 17th century the forest line curved sharply southwards to enclose much of Rohilkhand. Further out, the forest pierced the Ghagara. But now only a little of it survives north of the Ghaghara, and none to its south. All stretches of forest and scrub scattered in South Awadh as late as 1837 have been completely cleared. The forests of Central India tend to show a less traumatic change, though the withdrawal and fragmentation here too has been very considerable.



After National Atlas of India Plates 102-105

Fig. 3: Upper & Middle Gangetic Basin: Forests & Scrub (Excluding Himalayan Forests) 1951

Evidence regarding the presence of animals such as wild elephants, cheetahs, and wild buffalo, is also of help in identifying forests and wastelands in the 16th-17th centuries. Such evidence enables us to extend our study of forest and grassland zones beyond the Gangetic Basin as well.

The presence of wild elephants offers, perhaps, the firmest evidence about forest. There would, of course, be forests without elephants, but there could be no wild elephants without dense stretches of forest, undulating or hilly ground and fresh water streams. Since on an average an elephant consumes about 200 kg of green fodder a day, and wastes an equal amount in the process, a small, sparse, or degraded forest cannot sustain elephant herds (Israel and Sinclair n.d.: 83). Thus regions where wild elephants were found can safely be assumed to have contained large forests.

Elephants were much sought after in Mughal times, and Abu'l Fazl (1595-96: 132) offers in detail the information about places where wild elephants could be caught. This evidence can be supplemented by later sources (Habib 1982). It appears from our evidence that a wide belt containing herds of wild elephants stretching from Bihar and Orissa to Malwa and further west to the borders of Gujarat existed. This belt has been designated by Habib (1982: 38) as the 'Great Central Indian Forest'. Wild elephants could be caught in the areas of Dohad and Rajpipla in Gujarat (Lahori 1647-48: 331). According to the author of the *Mirat-i Ahmadi* sometime before 1761 wild elephants no longer came to Rajpipla because their 'forest route' linking Rajpipla with Malwa had been cut off by human settlements (Ali-Muhammad Khan 1761: 214). Now the forests in Malwa and much of Madhya Pradesh have become so fragmented and sparse that areas where wild elephants can roam have been reduced to the border districts of Madhya Pradesh and Orissa. In the Deccan, wild elephants roamed near Tirupati. Of course, none are found here today. Another map (Fig.4) brings out the extent of the retreat of elephant-forests all over India since c. 1600.[2]

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[2] The depiction of the limits of the zone of wild elephants and localities of cheetah c.1600 on this map (Fig.4) are based on Irfan Habib's *Atlas*. Stracey (1963) has been used for depicting areas containing wild elephants in 1951.

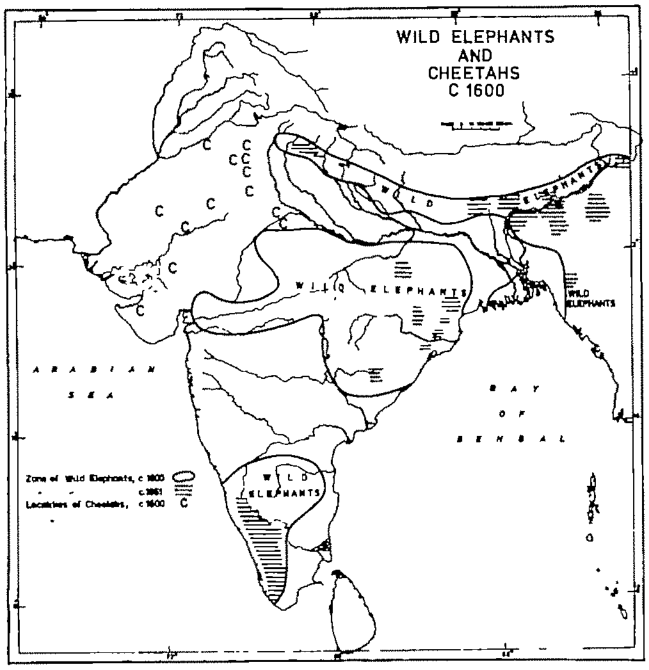
WILD ELEPHANTS AND CHEETAHS C 1600
WILD ELEPHANTS
WILD ELEPHANTS
WILD ELEPHANTS
ARABIAN SEA
BAY OF BENGAL
Zone of Wild Elephants, c 1600
c 1961
Localities of Cheetahs, c 1600
C

Fig. 4: Wild Elephants and Cheetahs c. 1600

Mughal Emperors were very fond of hunting. Akbar had cheetahs caught to be tamed and used in hunting deer. The localities where these animals were caught are therefore well documented in Mughal accounts. The cheetah's habitat is not thick tree forests but rocky tracts or low rugged hills bordering on wastelands and land with tall grass where he could find his prey. Cheetahs were found in West Panjab in the Lakhi Jungle on the northern bank of the Sutlej, and at Pattan, Bhatnair, Bhatinda and Sunam, where imperial hunting grounds were located. The other localities of cheetahs in Rajasthan were the scrub in close proximity of rocky regions or desert at Jodhpur, Merta, Nagaur, Jhunjhunu and Amarsar. Cheetahs were also found in Gujarat, near Patan and Navanagar, and, within Madhya Pradesh, in or near the Chambal ravines, close to Gwalior. While it is possible that the human preying on deer has been responsible for the cheetah's extinction in India, a great reduction in grassland owing to the expansion of cultivation might be a more probable cause.

Another animal to consider is the wild buffalo whose presence attests the existence of swamps and large expanses of wastelands with tall grass or drier grounds drained by nullahs and scattered trees. In the 16th-17th centuries wild buffaloes were found in Awadh (Abu'l Fazl 1595-96: 433). As late as the 1830s their presence is attested in southern Awadh (Butter 1839: 5). An Uzbek traveller noticed large herds of them, near Burdwan in Jahangir's reign (Balkhi 1640-41: 30-31). Manucci found them in the Sundarbans in Bengal (Manucci 1712:87). At present, wild buffaloes are found in none of these areas, being confined to Assam, North Bihar and parts of southern Madhya Pradesh.

Some evidence is forthcoming about the presence of rhinoceros in regions where it is now absolutely unknown. For example, Abu'l Fazl (1595-96: 514) reports its presence in sarkar Sambhal. However, there are two distinct species of this animal in India with totally different habitats, viz., great one-horned one who being a grazer lives in tall grass jungles in swampy and marshy ground and a lesser one-horned species that is found in swampy forests since it is not a grazer a but browser (Tekader 1983: 89-91). The evidence about rhinoceros is not of much help to us in establishing the presence of dense forests.

The impact of this immense change in the extent of forest and grassland has naturally had far-reaching consequences for the economy. The much larger extent of forest in Mughal times must have provided certain important products. First, there was a larger supply of timber for construction and ship building, fire-wood, charcoal, gum lac, and tasar silk. Secondly animals such as wild elephants were economically important when caught not only as war animals but also as beasts of burden. Cheetahs were caught and trained to hunt deer, and were much in demand from the Imperial Court and the aristocracy.

The forests in the proximity of Agra and Lahore provided 150,000 *mans* of fire-wood annually to the imperial household alone. For bringing this quantity 600 carts were reserved (Abu'l Fazl 1595-96: 151-2). In the 1680's timber worth Rs.5000 was brought from Khelaghar in Dehradun to Delhi for use in construction of a noble's house (Malikzada 1684: 146). It was the abundant supply of good quality teak wood from the forest in southern Gujarat in the 17th century (Foster 1906: 65, 69) that made the revolutionary change in the ship-building industry possible in Surat and neighbouring ports (Habib 1980: 37-38).

Certain forest products have now lost their importance. In the 1860s Cunningham complained that as a result of the gradual disappearance of the 'great forest of Narwar' there was a steep increase in prices of charcoal and thus in prices of iron and some other local manufactures (Cunningham 1864: 325). But coke produced from coal mines in eastern India was soon amply available and provided a substitute for charcoal.

The large area under scrub and forest meant availability of larger tracts of pasture. The fact that four oxen, two cows and one buffalo were allowed free of tax per plough in Akbar's time (Abu'l Fazl 1595-96: 287) suggests that the livestock available to the peasant in Mughal India was considerably larger than what his successor had in the opening years of this century. The presence of scrub in close proximity of cultivated zone was ideal for cattle. The ground underneath trees remained thickly covered with grass from the end of June to the middle of January while in the remaining part of the year fodder was provided by fallen leaves. The areas of scrub were also used as breeding grounds for cattle (Moreland 1953: 1-27). The larger numbers of cattle relative to ploughed area naturally implied more manure for agriculture even if the droppings were not accumulated and part of them were used as fuel.

The smaller size of land under the plough not only implied a favourable land-man ratio but also made possible a shifting of fields to avoid decline in fertility on account of continuous cultivation. In other words, there could be a larger extent of fallows and an easing of pressure on the soil.

From the uninhabited we may now pass on to examine the inhabited zone which, as we have seen, was far more constricted in c.1600 than in c.1900.

About the geographical distribution of our population one can perhaps only speculate broadly on the basis of the varying degrees of extent of cultivation in different regions that we have already discussed. The level of agricultural technology remaining largely constant between 1600 and 1900, one may legitimately assume a higher concentration of population in areas where a larger proportion of land had been brought under the plough relative to the beginning of the 20th century. Based on this criterion the middle Doab seems to have been most thickly populated while the population density in Rohilkhand and eastern U.P. must have been much lower. Another densely populated area of the Mughal Empire was Gujarat (excluding Saurashtra). Even on this general level, we can only make an assumption for a limited area of the Empire for which the measured area figures are available. We can, however, form a better idea by comparing the number of villages in various regions in Aurangzeb's time and in 1881 (Habib 1963: 1).

Interestingly enough the number of villages in Aurangzeb's time in most areas was either appreciably higher than or equal to what it was in 1881. In Bengal, Bihar, Sind, Kashmir and Khandesh, villages in the 17th century were as many as in 1881. But in the *subas* of Awadh, Allahabad and Malwa the number of villages was much higher than in 1881. The villages in Agra, as counted in 1881 were only two-thirds of the numbers reported for the later part of the 17th century. In Delhi this tendency is more pronounced, the number of villages in 1881 being only one-half of what they were under Aurangzeb. For Ajmer the figures are incomplete but the village lists in Nainsi's *Vigat* indicate that the number of villages in western Rajasthan remained almost constant between the 17th and the close of the 19th century (Bhadani 1983).

Taking into account the extent of cultivation in these regions one may legitimately infer that the size of villages in Mughal times was on the average much smaller. The population grew from about 145 million in c.1601 to 285 million in 1881 (Davis 1951: 30). Assuming that there was no big change in the relative distribution of population, one should have expected a corresponding increase in the number of villages if the size of the average village remained the same. Therefore, even if the number of villages remained constant between c.1700 and 1881 one can safely assume that the average size of villages in Mughal times was about a half of what it was in 1881; and if there were more villages in c.1600, the average size must have been smaller still. Presumably, where the number of villages had decreased, smaller settlements have been absorbed by the expansion of the larger ones, or have been abandoned altogether. Given these changes, the fields in the Mughal times must ordinarily have tended to be closer to the village sites (and so implied a smaller loss of time in going to the field) than in recent times.

The Mughal Empire could well boast of a number of towns that compared with, if they did not exceed, the larger cities of the world in size. Besides these big towns and cities there were a number of smaller towns that were mainly administrative headquarters where the houses were built largely of mud with thatched roofs. Roe reported that between Burhanpur and Surat the 'townes and villages are all built of mudd' (Roe 1619: 137). Even in the major towns of the Empire such as Delhi, besides the imperial buildings the use of burnt brick was confined to only a few houses belonging to grandees. As to the other houses belonging to "petty omrahs, officers of justice, rich merchants and others very few are built entirely of brick or stone, and several are made of clay and straw". The lower classes, of course, had thatch-roofed mud houses which were destroyed by the thousand by fire during summer (Bernier 1668: 246).

Thus while the towns would not have been impressive looking and probably appeared more "a collection of many villages" (Bernier 1668: 246), the smaller use of burnt bricks would have avoided the adverse impact of brick kilns which today so badly scars the soil and adversely affects horticulture.

However, on balance, if the changes in ecology have affected the 'human capital' adversely the situation four centuries ago too was by no means ideal. In spite of all the advantages of favourable land-man ratio and larger number of cattle, the vagaries of nature and the cruelties of man could precipitate famines carrying away hundreds of thousands, if not millions. The "law of the jungle" prevailed in much of human society.

Quite obviously, if one must look back with a certain sadness at how much of Nature we have lost since 1600, one must at the same time realise that the ultimate peace with Nature has to be accompanied by a human treatment of man by man.

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(In the case of pre-modern works the year is the year of compilation or of the closure of period of narrative. The pre-modern dates are often in Hijri years which normally overlap two Christian years).

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A Preliminary Palynological Study of Alluvial Sediments around Nirgudsar in the Ghod Valley, Upland Maharashtra

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Introduction

Western Maharashtra is essentially an erosional landscape dominated by denudational surfaces and valley pediments developed on basalts of Cretaceous-Eocene age. The terrain is drained by allochthonous streams like the Godavari, Bhima, Krishna and their tributaries. Laterite crusts of the Early Tertiary cap the higher denudational surfaces. Late Quaternary alluvial fills disconformably cap either the basaltic rocks or laterites in different river valleys of western Maharashtra (Kajale 1979; Kale and Rajaguru 1986). This region has practically no natural lakes of high antiquity and the absence of peaty intercalations in Quaternary formations is a common feature. As a result, palaeoenvironmental studies are primarily based on the study of geomorphological features such as cut and fill terraces and their associated sediments, vertebrate fossils and Stone Age tools as exemplified by recent studies in the Ghod Valley (Kajale *et al.* 1976). On the basis of a large number of radiocarbon dates as well as geochemical and mineralogical characters of the fluvial sediments (Rajaguru 1970) it has been observed that the region under consideration has experienced variations in monsoonal rainfall in the last 40,000 years. Interpretations regarding palaeoclimate are, however, broad-based or of a very general nature and have, so far, never been supported by traditionally accepted parameters like diatom and pollen studies on the Quaternary sequences (Rajaguru 1970). Earlier attempts of pollen analysis of late Quaternary deposits by the first author were not particularly successful. It has been generally thought that the alkaline and minerogenic nature of alluvial sediments, though rich in archaeological materials, were mainly deposited in an oxidising environment (Kajale *et al* 1976; Kajale and Deotare, in press) and have been subjected to groundwater fluctuations. These factors might therefore, have been responsible for the poor recovery of pollen and spores. Dark brown clay bands of varying thickness (2 to 10 cm) intercalated in the Late Pleistocene silt of the river Ghod have originated in a floodplain pool environment. They have yielded a few pollen of Holoptelea, Acacia, Pinus, etc. (Vishnu-Mittre and Gupta 1973) but have not allowed for the reconstruction of the palaeoenvironment or the pollen stratigraphy for these alluvial sediments.

Field and Laboratory Observations

During the course of multidisciplinary investigations (Kajale, 1979)in the Ghod Valley, one of us (MDK) discovered an interest ing evidence of ancient buried channel deposits in the upper reaches of the Ghod Valley at a proposed dam construction site at Nirgudsar (19° 2' 30" N : 74° 58' 15" E), about 60 km north-northeast of Pune, between the villages of Ausari-Khurd and Pargaon. Engineers from the State Irrigation Department, Maharashtra had taken a pit on the left bank of the River Ghod. Incidentally, they discovered a piece of semi-carbonized wood at a depth of 5 m below the modern bed level (and also drew our attention to this). The wood was embedded in carbonaceous dark brown silty clays. It has been dated by radiocarbon assay to c. 38,000±3200 B.P. (BS43). The carbonaceous clays represent buried pool sediments laid down in a braided course of the river Ghod. This event has been assigned to terminal Pleistocene (Kajale *et al* 1976). The carbonaceous silty clay is slightly acidic (pH 6.5) and contains 2% organic carbon. It was hoped therefore, that these sediments would have proved suitable for pollen preservation. The initial results of pollen analysis are reported below.

The lateral extent of the carbonaceous deposits could not be ascertained because of the obvious limitations in excavations at the dam construction site. Pollen extraction of the deposits was carried out by the usual method involving HF treatment (Faegri and Iversen 1965) but without the acytolysis. The samples contained pollen grains belonging to various families such as Chenopodiacea/Amarantaceae, Cyperaceae, Gramineae, Compositae (*Artemisia* type), Brassicaceae type, Combretaceae (*Terminalia* type), etc., as well as a great diversity of fungal remains. Detailed quantitative work on the microfossils is in progress. The pollen assemblage represents a local riparian vegetational environment similar to that observed in the present day channel pool. Often the surrounding banks get encroached by trees such as *Acacia arabica*, *Terminalia arjuna*, etc. and pollen released by these tree species could easily get incorporated into the local pools supporting herbaceous vegetation, where suitable conditions (slightly acidic pH, anaerobic and relatively organic rich swampy situation) prevail. These could have contributed towards the preservation of microfossils even though the associated brownish silts and gravels have not preserved microfossils due to the strong aerobic environment.

Discussion

The discovery of a semicarbonised piece of wood datable to c. 39,000 B.P. and the preservation of pollen in organic rich deposits is extremely significant from the view point of the Quaternary geomorphology and archaeology of the Upland Maharashtra. As the wood sample comes from 5 m below the present bed level of the Ghod, it confirms our earlier notion (Kajale *et al.* 1976) that during the early part of the late Pleistocene, most of the streams in western Maharashtra had deeply entrenched courses. This was followed by an aggradational phase as a result of decreased rainfall during the terminal Pleistocene (c. 20,000-10,000 B.P.). From the archaeological viewpoint, this evidence has helped us to date the Middle Palaeolithic cultures in the Ghod Valley in particular and Maharashtra in general to the early part of the late Pleistocene.

Acknowledgements

The authors are grateful to the authorities of the Department of Minor Irrigation, Maharashtra State for kindly drawing their attention to the discovery of wood at the dam site. Sincere thanks are due to Dr. S. Rajagopalan, Head of the Radiocarbon Laboratory, Birbal Sahani Institute of Palaeobotany, Lucknow for dating the wood sample.

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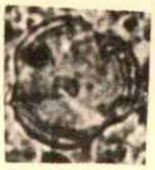
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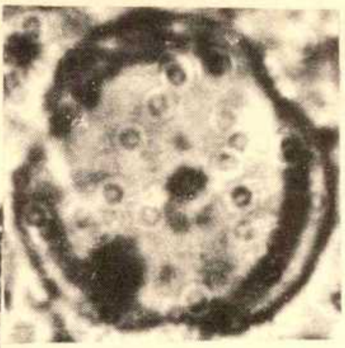
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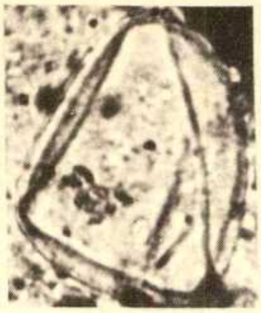
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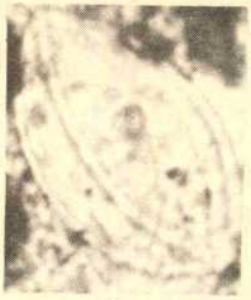
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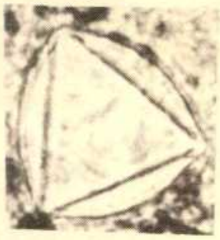
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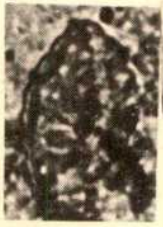
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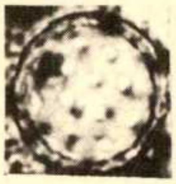
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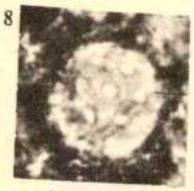
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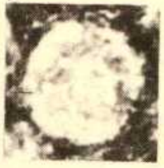
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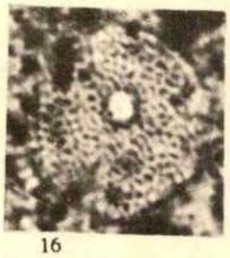
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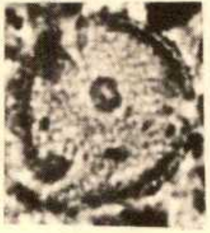
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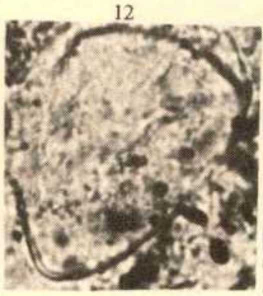
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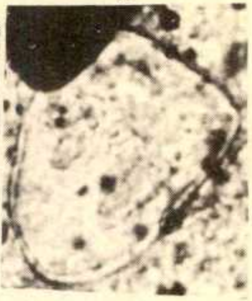
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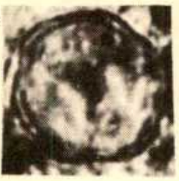
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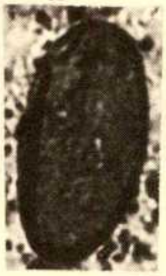
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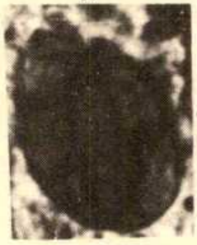
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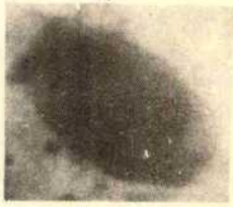
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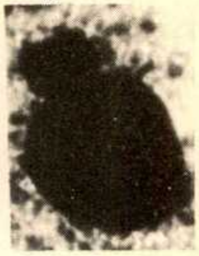
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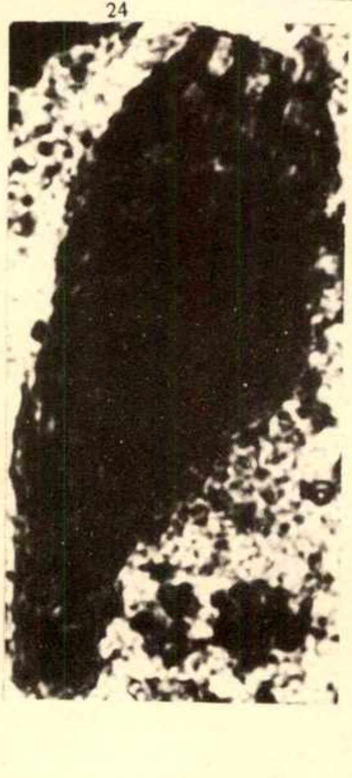
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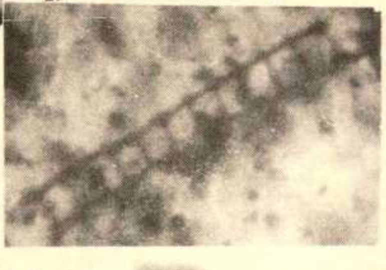
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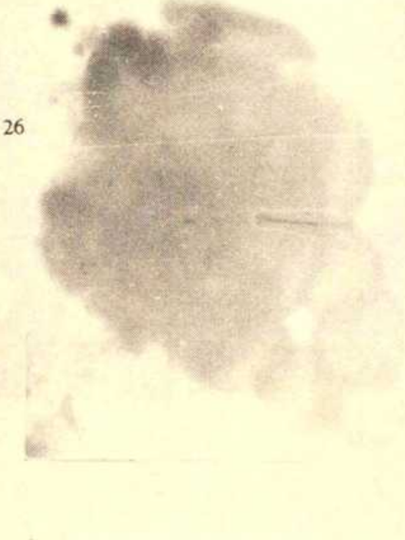
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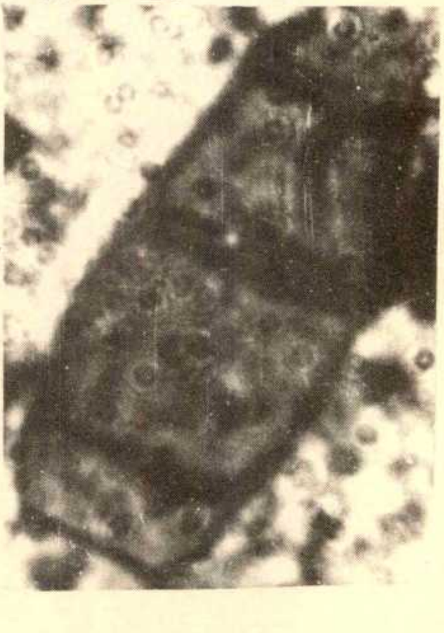
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Explanation to Figures

Fig.1: (1)General nature of the late Quaternary deposits in the Ghod Valley showing basal gravel yielding Middle Palaeolithic tools and animal fossils and overlain by old silt and young silt,

(2)Close view of the calcareous,compact old silt (terminal Pleisltocene age) generally devoid of pollen,

(3)Close view of the young silt (Holocene age) showing loose friable nature and prominent lamination,

(4)General view of the site at Nirgudsar showing late Quaternary deposits,

(5)Close view of the old silt exposed at Nirgudsar showing kankars and a molluscan shell (MS),

(6)Close view of the exposed portion of the buried channel at Nirgudsar which yielded carbonaceous sediment and the semi-carbonized wood,

(7)Close view of the carbonaceous sediments yielding microfossils,

(8)Channel pools in the modern channel of the River Ghod,

(9)The riparian vegetation in the modern gravel pools similar to the one visualised through pollen analytical evidence.

Fig.2: Microfossils from the buried channel sediments,usual mag nification 1000 x, subsequent enlargement thrice.

(1) and (2) Compositae (Artemisia type),
(3),(4) and (5) Graminaceous pollen type,
(6),(7),(8) and (9)Chenopodiaceae/Amarantaceae type,
(10) and (11) Brasicaceae type,
(12) and (13)Cyperus type,
(14) Combretaceae (? Terminalia) type,
(15) to (27) Fungal remains.

Mesolithic Occupation around Dhansura, District Sabarkantha, Gujarat: A Preliminary Study

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Introduction

The alluvial plain of northeast Gujarat, drained by the Sabarmati and Mahi rivers and their many seasonal tributaries, is covered by stabilized sand dunes which form a rolling topography. Those dunes, which are not under cultivation, are covered by thorny scrub vegetation. Often the dunes are arranged around depressions of diverse sizes which form lakes and ponds that carry water for varying months of the year, depending on the depth of the depression and the annual rainfall. The region has long been known for its dense concentration of Mesolithic sites (Sankalia 1946, 1955, 1956, 1965; Sankalia and Karve 1949; Subbarao 1952; Karve-Corvinus and Kennedy 1964; Malik 1966; Allchin and Goudie 1971). The recent discovery of three sites in the vicinity of Dhansura town adds to our knowledge of Mesolithic history. There is little doubt that further search of the dunes in the area will lead to the discovery of many more sites.

Environmental Setting

Dhansura (23° 20′ 50″ N : 73° 15′ 10″ E) is a small town in the Sabarkantha district of Gujarat. It is located about 85 km northeast of Ahmedabad along the Ahmedabad-Modasa and Bayad-Modasa highway. The landscape, all the way from Ahmedabad up to the north of Dhansura, is dotted by low sand dunes and presents a rolling topography. A small seasonal stream, the Majham, a tributary of the Vatrak, flows a few kilometres to the west of the town (Fig. 1). Numerous lakes dot the landscape, and several depressions of varying sizes seen around the town are obviously remnants of ancient inter-dunal lakes, so typical of the topography of north Gujarat (Figs. 2, 3). It is noteworthy that the Survey of India topo-sheet (No. 46E 3 & 7; 1 inch = 1 mile) based on a survey carried out in 1878-79 shows most of the land around the town to be covered by swamps. These lakes, now very shallow and dry during the summer months, must have been perennial during pre-farming times when rainfall was higher, vegetation cover denser, and consequently the rate of evaporation slower. They must also have been the major source of water for human and animal populations, and indeed the major ecological factor in the human occupation of the surrounding sand dunes. Isolated outliers of the Aravalli hills are present north of the town. Though much deforested, these hills still retain a thin cover of dry deciduous vegetation and harbour a certain amount of wildlife.

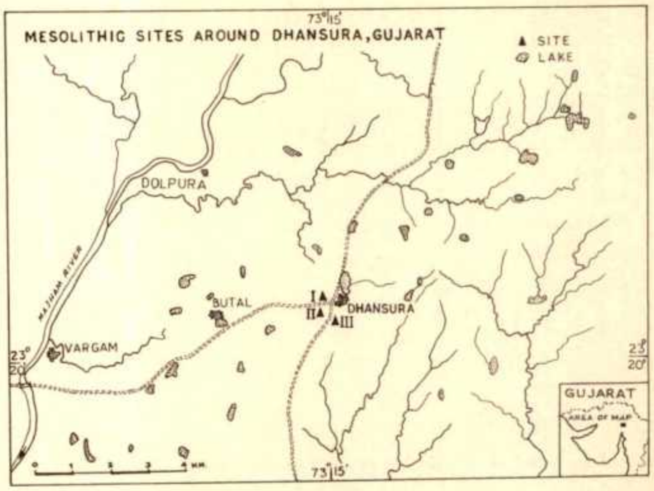

Fig. 1. Map of Dhansura region

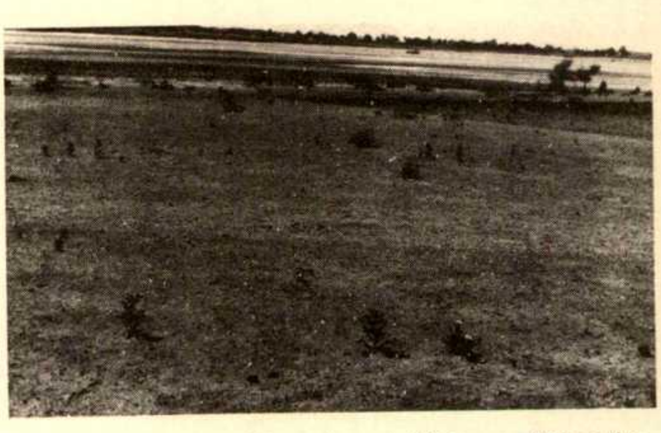

Fig. 2. A dried-up lake to the east of Dhansura III Locality

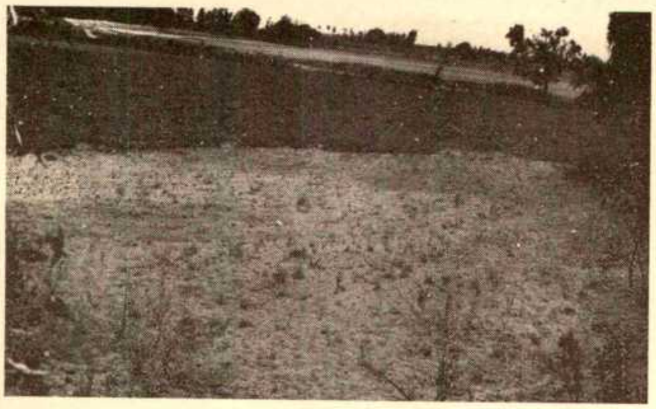

Fig. 3. Another dried-up lake to the west of Dhansura III Locality

Evidence of Mesolithic occupation occurs buried in the dunes on several sites, and it has been exposed by cuttings made in the compacted dunes for quarrying clayey material. Three archaeological localities, named Dhansura I to III, all located in the neighbourhood of the town, were discovered by the second author in 1987, and were examined jointly by us in April 1988.

This paper presents a preliminary report on the location and stratigraphy of the sites and on the archaeological material found on them.

The location and stratigraphy of the three sites are as follows:

Dhansura I

This site is located about 1 km northwest of Dhansura town and about 200 m west of Dhansura-Modasa highway. A dirt track leading from Dhansura to Dolpura village cuts through the dune containing the archaeological site. The site is locally known as *Gor-Mati-ni-Khan* (quarry of building earth) because compact, clayey earth produced by the weathering of the dune is quarried from here by the village people. A 2.5 m thick cliff has been exposed by quarrying on the western side of the dirt track. Stone artefacts and fragmentary animal bones are exposed in the cliff between 0.50 and 1.50 m below surface. They also lie scattered on the ground surface at the base of the cliff, having been discarded by earth diggers. A human skeleton in an extremely fragile condition was seen buried in the cliff section about 1 m below the surface in an extended position and in a north-south orientation(Figs. 4, 5). For want of necessary facilities at the time of examination of the site it could not be lifted. The flat ground just above the cliff is covered with an eucalyptus plantation.

Dhansura II

This site is located about 400 m south of Dhansura I and is separated from the latter by a semi-metalled road leading from Dhansura to Murwara town. The site is known as *Bahera Timbo* as a *bahera* (*Terminalia belerica* Roxb.) tree stood on it in the past. The site has been exposed due to quarrying over a large area for earth for the embankment of a nearby railway line. The cliffs of the quarry have a thickness of 1.5 to 2.0 m. The sand in the cliffs is deeply weathered to a blackish colour and is very compact, having a pedal structure. Stone artifacts and bone fragments are exposed between 0.40 and 1.50 m below the surface. The depression produced by the quarry as also the land around it are under cultivation (Figs. 6, 7).

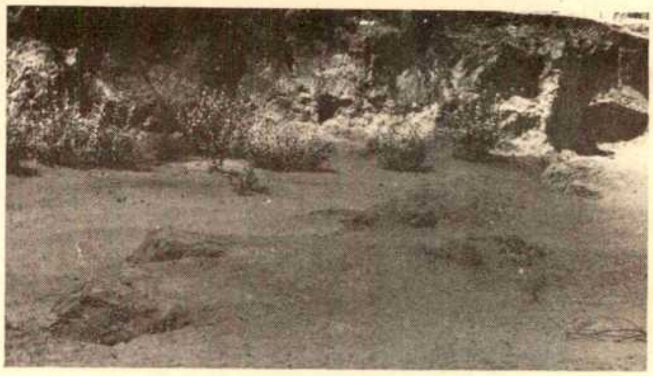

Fig. 4. A view of the quarry in the Gor-Mati-ni-Khan dune

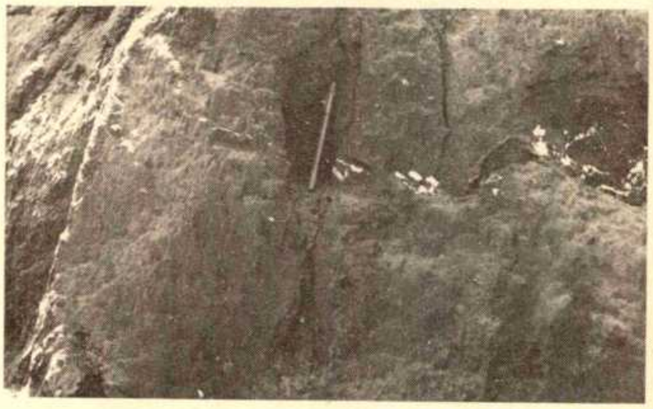

Fig. 5. Close-up of Fig. 4 showing an extended human burial in a highly distintegrated condition

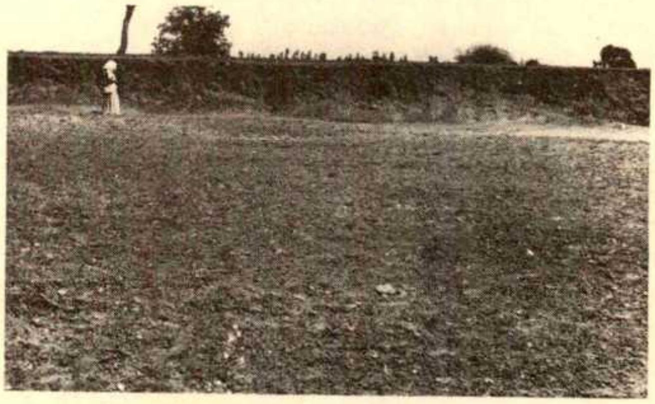

Fig. 6. A view of the cutting in the dune at Dhansura II Locality produced by earth quarrying for the nearby railway embankment

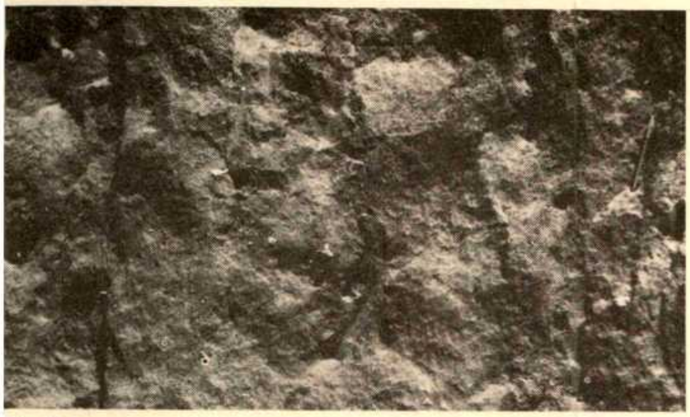

Fig. 7. Close-up of Fig. 6 showing quartz artefacts in the dune section

Dhansura III

This locality is situated about 1 km south of the town on the eastern side of the Modasa-Ahmedabad highway. A distribution station of the Gujarat Electricity Board (GEB) is located by the side of the road over an area of several acres. Earth was dug during the construction of the station from its northern and eastern sides, producing many pits and exposing steep sections in the dunes. A certain amount of quarrying still goes on in the vicinity of the station. Stone artifacts and animal bone fragments occur in the quarry sections from just below the surface to a depth of about 2.0 m. There are two large depressions, spread over several hectares, near the site, one on the eastern side of the GEB station and the other on the western side, across the road. The depressions, now partly under cultivation, carry water during the monsoon, and are obviously remnants of former lakes.

Stone Industry

The stone artefact assemblages reported here come from selective collections from the dune sections in the quarry pits and from the material fallen on the ground from the quarry sections at the above-mentioned three localities. It comprises over 400 artefacts, the majority coming from Locality I. As the large artefacts like cores, worked pebbles and flakes are more easily visible in the sections, the collection is naturally biased in favour of them, and is not representative of the original composition of the assemblages at the localities. For this reason a statistical analysis of the material will be misleading, and is not attempted here. Only a qualitative account of the industry is presented. A true picture of the industry can emerge only when the sites are excavated and sand is sieved during excavation to ensure that all artefacts, including the tiniest chips, are retrieved.

The assemblages from the three localities are quite homogeneous in respect of their stratigraphic context, state of preservation, raw material, size of the artefacts, typology, and techniques of manufacture, and they can therefore be regarded as belonging to a single industry.

Raw material

The vast majority of the artefacts are made of quartz both opaque and translucent and a small proportion of chert, chalcedony and quartzite. The raw material was obtained in the form of pebbles, probably from the bed of the nearby Majham stream, since a number of cores and flakes carry pebble cortex on their dorsal surface. Also a few hammerstones and a single anvil in the collection are pebbles modified by use.

Typology and Technology

The majority of the artefacts are flakes ranging in size from 2 cm to 8 cm in length, and from 1 cm to 5 cm in width (Fig. 9, Nos. 2-5, 9, 11, 14-15). The primary flakes carry pebble cortex on a part or the whole of their dorsal surface while the secondary flakes, which are in a majority, carry multiple scars and no cortex. There are a a number of typical Levallois flakes as well (Fig. 8, Nos. 6-7, 10, 12-13). All the flakes have sharp edges and some bear distinct marks of use in the form of pseudo retouch or edge damage. There are several amorphous and discoidal flake cores with multiple scars (Fig. 10, No. 6). There are also a number of cylindrical or squat fluted cores with multiple narrow and shallow parallel scars on them (Fig. 9, Nos. 16-22). Both blades (Fig. 8, Nos. 20-22; Fig. 9, No. 8) and microblades (Fig. 8, Nos. 7-19, 23-26) are represented in the collection, the majority of them being broken because of their extreme thinness (varying from 2 to 7 mm in thickness). Most of them have a single ridge on their dorsal surface, and only a few have two or more.

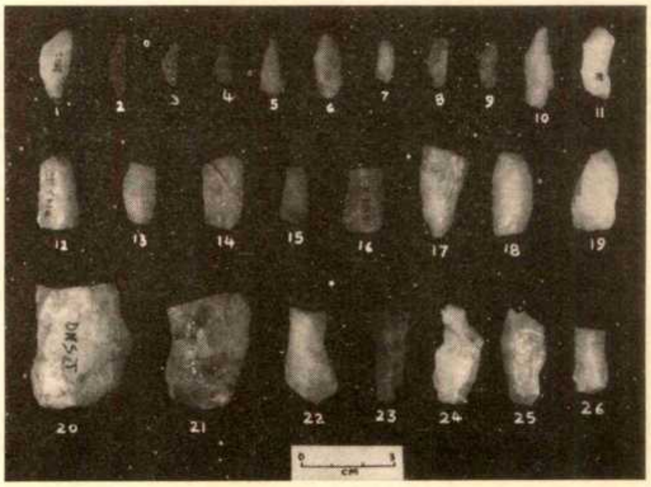

Fig. 8. 1-2, crescents; 3, isosceles triangle; 4, broken triangle (scalene?); 5, broken point; 6, blunted back blade; 7-19, 23-26, microblades; 20-22, blades. (3, 8-9, 15, 21, 23 chert; rest quartz).

The presence of several rejuvenation flakes in the collection shows that the blade cores were rejuvenated by the

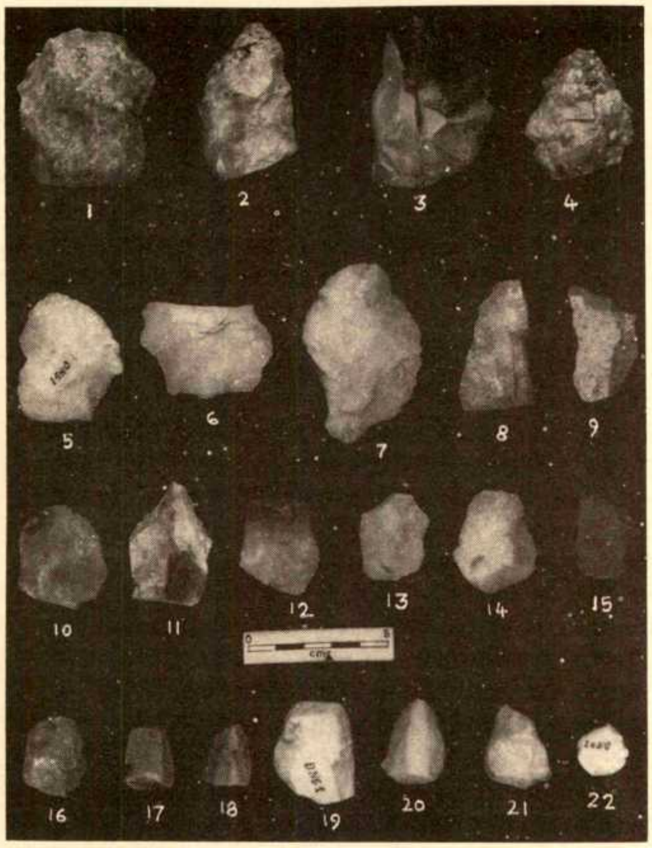

Fig. 9. 1, end scraper; 2-5, 9, 11, 14-15, flakes; 6-7, 10, 12-13, Levallois flakes; 8, broken blade; 16-22, microblade cores. (3-4, 9, 11-12, 15-18, chert; rest quartz).

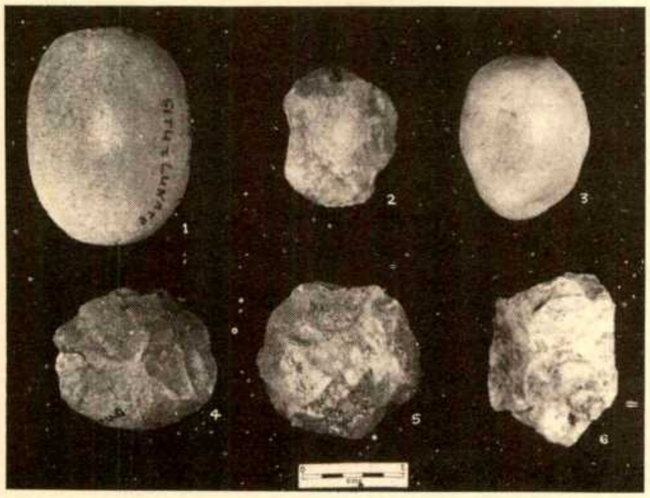

Fig.10. 1, hammerstone-cum-anvil; 2-3, hammerstones; 4-5, choppers; 6, flake core. (1-4, quartzite; 2-3, quartz; 5-6, chert).

removal of exhausted striking platforms and preparation of new ones. The predominance of flakes, chips, cores, worked pebbles, anvils and hammerstones in the collection is evidence that the tools were manufactured at each of the three localities.

Shaped Tools

Shaped tools in the assemblages are few and far between, mainly because of the selective nature of the collections. These include straight blunted-back blades (Fig. 8, No. 6), crescents (Fig. 8, Nos. 1-2), scalene (Fig. 8, No. 4) and isosceles (Fig. 8, No. 3) triangles among the microlithic forms, and end scrapers (Fig. 9, No. 1) among the non-microlithic forms. The heavy-duty component is represented by two choppers, one of them made on a quartzite pebble (Fig. 10, No. 4) and the other on a thick, discoidal flake of fine-grained chert (Fig. 10, No. 5).

Modified Tools

In this category there is one hammerstone-cum-anvil on a flat-based oval pebble of quartzite (Fig. 10, No. 1) and three hammerstones on quartz pebbles, two of the latter broken possibly during use (Fig. 10, Nos. 2-3).

Animal Bones

Animal bones are present at all the localities but they are highly fragmentary and small, and hence not amenable to zoological identification. Their presence, in conjunction with that of shaped and utilized tools, however, provides proof that the localities were occupation sites and not just workshops for tool manufacture. Proper excavation at the sites will almost certainly yield larger bones, specially teeth, which will provide us information on the faunal environment and subsistence strategies of the Mesolithic inhabitants.

Age of the Mesolithic Occupation

In the absence of radiometric dates from these sites it is not possible to say anything definite about their age. However, on the basis of the stratigraphy of the sites and absolute dates from other Mesolithic sites in Gujarat and neighbouring Rajasthan, a tentative dating can be suggested. On the majority of the sand dunes, both in Gujarat and Rajasthan, archaeological material of the Mesolithic period occurs on the surface and therefore dates to the post-dune formation stage. However, at each of the three Dhansura localities such material occurs embedded within the body of the dunes between 0.40 and 1.50 m below the surface. This means that when the Mesolithic groups occupied the dune surfaces, the climate was arid and sand movement and deposition was still taking place. Studies of pollens in several salt lakes and of clastic and chemical sediments of the Didwana salt lake in Rajasthan, supported by C14 dates, clearly show that the climate of northwest India during the terminal Pleistocene was hyper-arid and caused extensive dune-building activity. On the other hand, humidity set in at the beginning of the Holocene, and the period between 6,000 and 4,000 B.P. was the most humid when present-day saline lakes were perennially carrying deep fresh water (Singh *et al.* 1974; Wasson *et al.* 1984). The occupation at the Dhansura sites is therefore likely to date to the terminal Pleistocene or early Holocene. Thermoluminescence dates from the upper part of the weathered sand dunes at Amarpura (27^0 23′, N : 74^0 37′, E) in western Rajasthan, and Langhnaj (23^0 29′, N : 72^0 26′, E) in north Gujarat, quite close to Dhansura, range between 5,000 and 20,000 years B.P. (Singhvi *et al.* 1982). Since the TL dating of dune sands is still in an experimental stage, these dates may not be as precise as C14 dates. However, they do agree with the time range of terminal Pleistocene-early Holocene suggested by the palynological, sedimentological, and mineralogical analyses mentioned above.

Conclusion

This preliminary report on the Mesolithic occupations around Dhansura shows that the three localities are a part of the widespread Mesolithic occupation of the sandy plain of north Gujarat. Further and carefully planned exploration in the area is certain to bring more sites to light. The localities are archaeologically rich and promising. The presence of faunal and human skeletal material lends further significance to them. Systematic investigation of these sites in the form of excavation and analyses of lithic and bone materials will contribute substantially to our understanding of the hunter-gatherer adaptations in the region during the terminal Pleistocene and early Holocene.

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Report of The British Archaeological Mission to Pakistan 1980-89

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Since 1980, the British Archaeological Mission to Pakistan has been studying the Palaeolithic and Pleistocene sequence of Northern Pakistan in conjunction with the Department of Archaeology, Pakistan (since 1985), and in collaboration with the Geological Survey of Pakistan. This research has had three major aims:

i) to construct a chronological framework for the Palaeolithic assemblages of Northern Pakistan by the study of surface and excavated assemblages: with especial emphasis, wherever possible, on pieces in an *in situ* context,

ii) to reconstruct the environment associated with those assemblages by the collection of fossil vertebrate remains, and by the study of fossil soils and sediments, and

iii) to find hominid remains by survey and/or excavation and major fossil localities, especially those accumulated by carnivores such as hyaena and crocodile.

History

The history of this project falls into two distinct parts. The first has focussed on the Riwat area of the Soan Valley, near Rawalpindi. Much of this work, especially that done before 1985, was essentially small-scale and concerned with a major revision of the work done there by De Terra and Paterson in 1935 (De Terra and Paterson, 1939). The second part has taken place since 1985, in the Jhelum basin and particularly (since 1986) the Pabbi Hills, and involved major surveys for fossil material, and the participation of palaeontologists, from both Britain and the Geological Survey of Pakistan.

In 1980, Helen Rendell (University of Sussex), accompanied by Bridget Allchin (Cambridge), the Director of the Mission and S. Ashfaque of the Department of Archaeology, Pakistan, undertook a brief survey in the Soan Valley, in which Rendell revisited the major sections of De Terra and Paterson. She concluded that first, their relative chronology was incorrect; secondly, none of the features they identified as terraces were such; and thirdly, none of the Palaeolithic material they studied could be assigned a secure geological context. Consequently, a fresh start was required, and it was at that stage that I joined the project in 1981. A beginning was made on the mapping and dating of the Upper Pleistocene loess deposits near Riwat, because they were amenable to dating by Thermoluminescence method (TL), and were also the most accessible part of the landscape.

The results of this work on the Upper Pleistocene of the Riwat area will be presented in a forthcoming monograph (Rendell, Dennell and Halim, 1989 in press). In brief, they show that the Upper Pleistocene deposits comprise a complex loess sequence upto 15 m thick covering the last 70,000 years (Rendell and Townsend 1988); and that these overlie a complex series of post-Siwalik fluvial deposits, including an Upper conglomerate that contains a hemispherical disc core (dating to c.150,000 years ago). In addition, this monograph will report on an archaeological locality known as site-55 that was discovered by Rendell in 1980, and excavated over four months in 1981-82 by Dennell and Moth (University of Sheffield). This site is of interest in being the first open-air Palaeolithic site to be excavated in Pakistan. It comprises a tilted Siwalik conglomerate surface upon which a fresh assemblage of flakes, cores and blades was found which was probably made locally. Some of the blades were very thin, and some pieces could be regarded as microlithic, or at least very small. Out of about 1000 pieces, 64 or so conjoined in 20 sets. This assemblage is associated with a crude structure, comprising a wall footing, a pit and a circular niche. As no traces of fire or bone were found, there is no reason to regard it as a habitation site, and one interpretation is that it may have been a skin-working site. The loess overlying this assemblage and structure has been dated by TL to c.40-45,000 years ago (Rendell and Dennell 1987). As the late Soan is inadequately defined in Pakistan in terms of dating and tool types, this term should not be used to describe the flake and blade assemblage from this site. Until more is known, it is safer to refer to it simply in terms of its age.

In 1983, a hominid-struck piece was also found embedded in a lower conglomerate horizon at Riwat that contained a further 23 struck pieces, of which three are also considered as highly probable examples of hominid activity. At the time of discovery, the age of this horizon was unknown. In 1985, Rendell undertook an initial palaeomagnetic sampling of the 68m of deposits overlying this horizon, and showed that all these exhibited a reverse magnetic polarity, and were thus older than 0.7 million years ago. In the following year, she sampled this section in greater detail, and showed that it was an integral part of the Soan syncline, and dipped under a horizontally-bedded horizon dated by the Fission-Track method to 1.6 million years ago. If 0.3 million years are allowed for the accumulation of the 68 m of deposits overlying the artefact-bearing horizon, its age is estimated at c. 1.9 million years ago (Dennell *et al.* 1988).

Further work at this locality occurred in 1988. The lower conglomerate horizon was traced over 5 km and further palaeomagnetic sampling was undertaken by Rendell to tie it into Reynolds's (1980) Miocene-Pliocene section in the same area. In addition, a hominid-struck flake was found 40 m from where the first piece was discovered in 1983. Rendell also took conglomerate samples from where one of the artefacts was found in 1983, and has since confirmed that it has not been redeposited. The integrity of its context has also been confirmed by a latex mould of the socket left by the removal of the artefact, showing that the flakes detached from it were removed before incorporation into the gritstone.

The Jhelum Basin: Dina, Jalalpur and Rohtas

In 1983, the Mission shifted its focus to calibrating the Early Palaeolithic. It was able to take advantage of palaeomagnetic work by previous American and Pakistani investigators who had dated numerous Siwalik sections in the Jhelum basin covering the Miocene to Pleistocene (Opdyke *et al.* 1979). At Dina and Jalalpur, Acheulian-type hand-axes were found embedded in conglomerates just above the Brunhes-Matuyama boundary, and dated to 0.5-0.7 million years ago (Rendell and Dennell 1985). In 1985, the Mission began its collaboration with the Geological Survey of Pakistan and started to investigate fossil vertebrate assemblages from the Upper Siwaliks, as these had not been studied in detail in Pakistan for several decades. The survey team was thus widened to include three palaeontologists, [Rogan Jenkinson, Cresswell Crags Centre (Nottinghamshire), Sheilagh Sutherland (University of Sheffield), and Peter Whybrow of the British Museum of Natural History, London]. In that season, about 3000 fossil remains belonging to nine taxa were collected from deposits between 2.5 and 0.5 million years ago at Dina, Jalalpur and Rohtas. These indicated a faunal change, marked by an increase in elephants, bovids, tragulids, and a decrease in Stegodonts and was provisionally dated to c. 1.9 million years ago. However, the deposits from which these remains were derived were coarsely-sorted, and biased by a preponderance of large animals. These problems emphasised the need to work where sedimentary conditions had been gentler, resulting in the preservation of a wider range of animals.

The Pabbi Hills

The Pabbi Hills is an anticline containing 3500 m of fluvial deposits spanning 2.5 to 0.5 million years ago (Keller *et al.* 1977). In 1986, the Mission spent 10 weeks surveying sandstone 12, dated to 1.2-1.4 million years ago as this is traceable over several kilometres, and falls within the age range for the earliest hominids in Java. 12,000 fossils, representing 20 taxa, were recovered from 150 localities and erosional surfaces. Surface remains included very small anatomical elements (e.g. Third phalanges and milk teeth), and the remains of small animals (e.g. jackal size), and young ones. Much attention has been paid to detailed recording, so that each area/locality can be relocated on future occasions, and plotted on air photographs. Some localities were very rich: an example is site 73, where 2500 bones were collected. This site was excavated in 1986 and 1987 to recover taxonomically useful specimens, and is interpreted as a carnivore den.

A second 10 week field season took place in 1987, and concentrated upon horizons between 1.6 and 2.5 million years old. A further 15,000 fossils were collected from 350 localities or erosional surfaces. As in 1986, some localities were very rich, and many specimens from surface or sub-surface contexts were of very high quality.

In 1988, the Mission concentrated its efforts on the artefact-bearing horizon at Riwat (see above), and consolidated its work in the Pabbi Hills. Another 10 week season took place in 1989. Four weeks of survey along previously-unexplored parts of sandstone 12 resulted in a further 13,000 fossil remains, and the discovery of two extremely rich fossil localities, known as 610 and 642. The latter yielded 4500 specimens from an area 20 m by 15 m, and may be excavated later in 1989. In addition, a particularly rich fossil locality (site-362) that is c. 1.6 million years old, and which was discovered in 1987 was excavated, and interpreted as another hyaena den. Specimens included articulated segments of *Sivatherium* sp. hyaena, a complete set of bovid horn cores, and the remains of an eagle-sized wing.

Numerous stone artefacts have been found in the course of collecting fossil remains from erosional surfaces. 69 were found in 1986, 134 in 1987, 13 in 1988, and a further 89 in 1989. After study by Linda Hurcombe (University of Sheffield), these have shown remarkably few later chronological types, and as almost all have been collected from fossil-bearing horizons, the assemblage may represent a pre-Acheulean set of material (Dennell *et al.* in press). Three localities that had yielded both flaked stone and fossil remains in 1987 were excavated in 1989 to see if artefacts could be found in context. None was found, but the excavation of one (269) strongly suggests that the conjoining pieces of elephant scapula and the disc core found on the surface in 1987 came from a gritty horizon sealed by a loose sandy deposit within a sandstone formation dated to c. 1.6 million years ago. Further investigation of this locality is planned.

Future plans in the Pabbi Hills involve further excavation of hyaena dens to find taxonomically useful specimens, as well as (with luck) hominid remains; to continue to try to find artefacts in contexts over one million years old; and to reconstruct an accurate picture of the prevailing environment. Publication of a monograph on the fossil remains by Jenkinson and Dennell is in hand, and should be ready in 1990. It must be stressed that at present the sedimentological and palaeontological evidence do not permit any palaeo-climatic inferences, beyond the commonplace statement that the faunal spectrum is predominantly a grassland one.

As a result of the Mission's activities, it is now possible to conclude that i) blade and flake assemblages at Riwat date from 40,000 years ago; ii) hand-axes at Dina and Jalalpur date to c. 0.5-0.7 million years ago; iii) the earliest artefacts in Pakistan date to c. 2 million years ago. It has also identified - tentatively - a pre-Acheulian stone tool assemblage from the Pabbi Hills. In addition, the Mission has acquired a superlative and well-documented collection of over 40,000 upper Siwaliks fossils, and mapped in detail the Upper Pleistocene land surface near Riwat.

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Interview with Prof. J. Desmond Clark

By

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Professor J. Desmond Clark of the University of California, Berkeley, USA is the foremost authority on African Prehistory. He has to his credit the longest record of archaeological research and excavation in various parts of the world including India. He thinks there is great potential for studies on early man in the Narmada Valley and would like to work in that region. He was recently in India at the invitation of the Indian Council of Historical Research, New Delhi to attend a seminar on "New Archaeology" where he delivered a lecture on "Hunter-Gatherer Studies". His visit to the Deccan College was very productive. In this personal interview he was pleased to answer our questions which ranged from topics of general interest to his personal experiences in the field of archaeology.He also looked back at the state of the art of his times and the growing emphasis on interdisciplinary studies and the increasing potential of the discipline in the reconstruction of past life ways. At 73 he is still going strong and intends carrying out field studies in China and Africa.

What is the present status of our knowledge of human pedigree and the origins of culture?

That will rather require an encyclopedia of 10-12 volumes to answer that one. Because of the researches for over twenty-five years, particularly in Africa, tremendous amount of new information has come forward in the form of fossil material dating to about 5 Myr. ago and, after 2.5 Myr. ago associated with cultural remains so that one can see the morphological evolution of human lineage and how this goes hand in hand with cultural technological evolution. The evidence is nothing more than a bunch of tools and comes from the deposits dating to that time range. But you get much more information from indirect evidence to identify hominid strategies for resources, food getting, meat that was being obtained, scavenging or hunting etc. and the way in which what really started things off appears to be the decision by bipedal hominids within the *Australopithecines* and man-ape grade to start and to include meat, bone-marrow in their diet and that happened somewhere between 2.5 - Myr. ago. *Australopithecines* dating to 5 Myr. ago, had small brains, an ape-like face and hands capable of tool making though still adapted to tree climbing. No stone tools are known to have been associated with these fossils, but it has been recently suggested that the robust forms from South Africa may have used simple stone artifacts. As revealed by their anatomically more evolved structure and brain, they must have made use of simple perishable objects that they modified for use as tools-such as those made and used by chimpanzees, though those of the *Australopithecines* can be expected to have covered a wider range of uses. The oldest *Australopithecine* fossils (3.5 - 3 Myr.) show sexual dimorphism. Now it is recognised, there were at least three hominid lineages all evolved from *Australopithecus afarensis* ancestor. One line came from *A. africanus* to *A. robustus* (*Paranthropus*) in southern Africa; another from *A. aethiopicus* in East Africa and the Homo line leading to *Homo habilis* and *Homo erectus* in both north-east and South Africa.

The earliest Homo (man) grade is that of *H. habilis* dating from 2.3 to 2.4 Myr. However, more complete remains date from 2 Myr. onwards. This hominid had an enlarged brain and is significantly associated with the oldest evidence of tool manufacture. This is called Oldowan techno-complex, which represents a basic pattern of core (often a cobble) reduction for the production of flakes to be used in various ways. More importantly one notices the association of bone fragments with these tools. This association of hominids of increased cranial capacity and so brain size, with meat and bone marrow processing is considered highly significant. The increased intake of meat, obtained by foraging, perhaps also from hunting, can be seen to have led to expanded brain capacity and greater complexity. This, in turn, reflects the intentional manufacture of sharp flakes, to use as knives for processing the meat and other uses too. In Africa *Homo erectus* dates back to 1.6 Myr. While *H. habilis* was 1 - 1.5 m in height, adult *H. erectus* individuals are likely to have been 2 m tall, robust and with a much closer to our own. The contemporary stone artifacts show significant development over the Oldowan tool-kit, which continued up to 1,25,000 years before the present (B.P.).

But from 1.5/1.4 Myr. ago, a large, usually bifacially worked tool component made its appearance. These artifacts are known as handaxes and cleavers, are characteristic of what is called the Acheulian Industrial Complex. They are the first standardised tools to appear in the archaeological record. They are manufactured to a standard repeatable pattern which may show stylistic changes in time and space. But these tools are remarkable for the way in which they and the associated artifacts are repeated throughout the whole of Old World wherever the great techno-complex is found.

So thus it goes on: with the basis in meat eating leading to improved nutritious diet and enlarged brain, with tool-making, making it easier to obtain meat and do other things so that you can see the feedback relationship between culture and biological evolution.

How old is Modern Human?

This is an interesting question.

Up to a few years ago modern man was thought to have appeared suddenly about 40,000 years ago. That was actually in western Europe, around that time he appeared for the first time and more than 40,000 years ago in eastern Europe and then onwards he spread rapidly. The Neanderthal populations that existed 100,000 years ago were very specialized to cold climate and more efficient in food getting and other aspects of social organisation than the Lower Palaeolithic populations, and they certainly did not measure up to modern humans. Now as a result of work by molecular biologists who have been looking at DNA polymorphisms, variations in modern populations and mytochondrial DNA, which is inherited only through the female genes. These studies conclusively show that there are two basic divisions among the humans in the world. One is the African and the other Non-African. Much greater variability is present in African populations south of the Sahara and this implies a greater age as well. The Mytochondrial DNA shows a very slow rate of change, say 2-4% per million years. Using this as an estimate Allan Willson and his co-workers have come out with a suggestion that somewhere between 2,90,000 and 1,40,000 years ago the first female modern human appeared in Africa. Well of course, you have to have a breeding population as well. The DNA evidence implies that there can have been no genetic input into the modern gene pool by the previously existing populations in Africa and other parts of the Old World. However, physical anthropologists find it difficult to believe this, but that is what it is, unquestionably. And I suppose it means that modern humans must have had something at least, vastly advanced trait far surpassing any possessed by all other grades of humanity. For long I have been thinking, I still do, it was probably the ability to exchange information with a fully developed language system that was the basis of success of anatomically modern humans. Certainly it is quite remarkable that as yet the time range that we have is not all that precise because this theory is basically associated with the Middle Palaeolithic age - the suggested time, and this is beyond the lower limit of radiocarbon dating. There are those other methods, like the Thermoluminiscence, that are used, and if they are used to compare one could perhaps have more confidence in dates that are produced.

And in Africa, you can see the emergence of what appears to be anatomically modern human, in the fossils, that date round about 100,000 years or more B.P. These are cave sites and sites in the open which have been dated by U-series and thermoluminiscence dating methods. Before that one can see the emergence in the archaic *Homo sapien* populations of various modern traits which go side by side. Some of these fossils show not much more archaic traits. Others show much more modern ones. By the time one can get to the time range between 72,000 and 100,000 years B.P. we begin to find definite variety of the modern human fossils associated with Middle Palaeolithic. Now there is a population from Israel from the cave of Qafseh near Nazareth which is a Middle Palaeolithic site. The humans that are buried there are dated to 90-92,000 years B.P. The microfauna is thought to date back to 100,000 years. This is very interesting because it was thought that the modern humans first evolved in Western Asia or on the other hand it could be representative of the first moderns that actually got out of Africa. And thence globally in the years after 40,000 years B.P. We do not get fossils in the time range between 90 and 68,000 years in other parts of Eurasia to show when modern human spread. From South China there is a fossil which is said to be dated to about 67,000 years B.P. From the Far East, Borneo, there is a fossil dated about 35,000 years old and in Australia there is a certain evidence that Australoids got into Australia by about 40,000 years ago and the cremation burials at Lake Mungo date back to about 32,000 years. In India we do not have any modern human in the Late Pleistocene. But there is an interesting cranium (skull cap) from the Narmada river, from a gravel dating probably to late Middle Pleistocene or early Upper Pleistocene deposits. This looks to me a simple evolved archaic *Homo sapiens* such as the Rhodesoid populations from Africa south of the Sahara than the more archaic *Homo erectus*. When we go to Europe there we get better evidence of fossils from 35,000 years ago onwards.

Although language does not fossilise you can see this by a certain amount of circumstantial evidence in the form of a complex technology and social organisation and beliefs that were present in the Upper Palaeolithic in the very fine artifact assemblages which change, with much decreased abilities, in time in response to climate and environmental changes. You can see this in customs like intentional burial of the dead — it was also present in the Middle Palaeolithic, with grave goods, rudimentary ornamentation and a great variety of Cave Art, which show abstract ideology and precision in thought can only have been possible by a fully developed language system.

It has often been emphasised that the ancestors of modern humans had their origins in Africa. But in view of recent evidence of stone tools dating back to about 2 Myr. ago in Northern Pakistan some archaeologists are suggesting a polycentric origin of early human culture! How far is it valid?

Well, this claim for 2 Myr. age tool from the Soan valley in northern Pakistan is very interesting. The find needs to be obviously very carefully looked at and taken seriously. In Africa you have in lithology the evidence of fossils and culture. Fossils of hominids from somewhere between, I suppose, 5 and 6 Myr. But the split in the lineages between the apes (the African chimpanzee) and the humans must have taken place somewhere before 5 Myr. ago. These bipedal creatures living in the dry savanna did not make tools but they lived there quite success fully up to 2.5 Myr. Then we find the first stone tools produced in the archaeological record, the addition of meat and bone-marrow to the diet and we find the large brained hominids appearing which are known as *Homo habilis*, the man having the ability to manipulate tools and so on. The earliest date of *H. habilis* goes to 2.4 - 2.3 Myr. from the Omo valley (Africa) with more complete remains dating from 1.8 - 2 Myr. ago from various parts of East Africa associated with tools and broken bones. Up to 1.5 Myr. ago the activity was simple case of foraging strategy suggesting a strong possibility that stone tool manufacture began as a result of the need for a sharp cutting implement to penetrate through hides and to remove the meat from bones. The tool kit comprised knives (flakes with sharp unmodified edges), hammer stones etc. Round about 1.5 Myr. ago the stone tools were also put to use for pointing a digging stick for digging out edible tubers and other buried foods rich in carbohydrates. These tools are referred to as handaxes and cleavers belonging to an Industrial Complex called Acheulian. This spread very very widely throughout the whole Old World. Now these continued in Africa and continued to move out of the drier well-watered savannas into almost every kinds of ecological niche other than the rain forests and actual deserts. Around 1 Myr. ago they moved out of Africa into the Asian tropics first of all, and there we find *Homo erectus* in Java and in China and then probably somewhat later into temperate Europe and that the basis of the spread as far as we know. Now up to 1.5 Myr. ago all the tool making and fossil evidence is found only in Africa, it may be little close in Asia, as yet it has not been found. What we do find in Asia is that around 8 Myr. ago the apes, the *Ramapithecus*, *Sivapithecus* and those kinds of apes appear to have died out, although they appear to have continued in Africa out of the substrate very much acknowledged as hominid bipedal ancestor. So that in Asia they are as yet completely missing during that time range between 5-6 and 1.5 Myr. ago. I suppose so, at the moment it is the most expensive idea, but it does look as if humans did not get out of Africa much before a million years ago.

Now what we need, therefore, is to look at very carefully at the Asian evidence from northern Pakistan. We have to see how good is the dating? How good these are as stone tools? And if that is confirmed, in age, in context, then it is required to have drastic revision of evidences now dated. The dating is by Palaeomagnetic Reversal Analogy of the particular deep section at Riwat on the southside of the Soan valley. It appears that this was carefully and systematically done, has produced remarkable dating evidence for that particular section all of which lies over the sediments which are Reversed with the exception of the bottom part which is Normal. We know on the northside this section must be older than 1.5 Myr. and the Palaeomagnetic date suggests 2 Myr. or more. Now I have seen a cast of the stone artifact and I have little doubt that it is a tool. It may be a core of course. But the crux of the problem is the gravel conglomerate from which it has been extracted with ten other flakes. Is it in situ at the base of the Siwalik sequence or this gravel conglomerate is abutting against the base of the bottom-most section? This is a geological question which needs to be answered. If it is found to be in situ then of course there is need for systematic investigation in tropical Asia, i.e. we should look for the evidence of *Australopithecines*. And as yet there is no evidence to talk of evolution in Asia.

In recent years you have done some interesting work on the Indian Stone Age. Could you tell us about some potential areas of research in the Palaeolithic archaeology of India and what needs to be emphasised?

Well we worked in the Son valley in order to try to build up geological, sedimentological and geomorphological history of the region. I find that these large river valleys have high potential for finding lots of sites and artifacts, hopefully some fossils from the Middle Pleistocene (0.7 Myr.) upwards. And as yet older sediments appear to be missing from the rivers, apart from the Siwaliks, which is a crucial place for study. In all the southern part it appears that the deposits are missing, may be they are not, but concentrated efforts need to be made to tell if there are any Pliocene and Lower Pleistocene sediments in these parts of India and see if there are cultural remains in association with them. It is of course mostly from the secondary context along the stream courses or lag deposits where the artifacts have been moved around and redeposited that the evidence comes from at the present time. But there is a systematic effort to find in fine grained sediments, relatively undisturbed occupation sites, and these are the ones that are going to give clues to the cultural contents, behaviour pattern and the general increase in tempo of culture in India.

Caves, particularly the limestone caves, are obviously the important places that need to be investigated over a period of years. Some of these may well be deep, some of them may contain cultures that are old, comparable in age to those from the limestone caves in southern Africa dating back to 3 Myr. or so up to about 50,000 years B.P., will have in association with a whole lot of faunal material, stone artifacts and perhaps hominid remains also. So it is the limestone cave areas that need to be investigated. And as well when it comes to trying to understand better, then first of all you need to uncover and study the distribution of the artifacts and other features, bones and so on over a surface where the activities are taking place. That means you have got to excavate the surface itself over wide areas so that you can plot all those and see relationships between different kinds of tools, debitage and bone and so on. Hearth and garbage would tell you when you do ethnoarchaeology what kind of pattern it might be in the past. The sites have got to be looked at not in isolation but in relation to one another. And at a given time period you have to be able to connect sites together to show what kind of pattern of resource use and exploitation was in the territory of the prehistoric group, what is known as Spatial Archaeology.

There are more ways in which it is valuable to concentrate research efforts as well, of course, the rock art is another very interesting and very important source of information about behaviour of the early Mesolithic populations and later populations. One aspect of this is to show what kind of material culture behaviour is represented in the rock art and relate this again ethnographically, and the other is to try to determine the motives behind the rock art in the first instance. Perhaps even more interesting it may have something to do with trance. There is a rich corpus of rock art in the Vindhyas which has earlier stages and there can be no doubt that the paintings were made by hunter-gatherers and in its later stages it shows more clearly the impact of food gatherers and of Indian civilisation. Research on this is expected to follow two directions. Firstly, to relate the stages of art to the stages of occupation of the sites by the artists and at the same time to determine the behavioural traits, material culture and technology portrayed in the paintings in order to reach a possible understanding of daily tasks and events and the ways some of the artifacts in the occupation layers might have been used. Secondly, an enquiry into the beliefs and motives behind the art - the driving forces that found their outlet in the special kind of symbolism could be profitably attempted on the Vindhyan rock art. This could be a very significant new line of research into the connecting links which lie unquestionably with some of the aboriginal tribal groups still inhabiting the region.

For long it had not been possible in India to even think of early Pleistocene sedimentary deposits in the Peninsular rivers. Now that we have a volcanic ash marker bed dated to 1.4 Myr. we are beginning to realize its importance in archaeology and also a greater time depth for the cultures in India as well. You have now visited that site at Bori near Poona. What is your impression of the site?

Indeed you have made a very important find and it looks as if this ash which is present in various parts of central and northern India may be of same age, may be of different ages. It is important to be able to find the source of the ash whether it comes from Africa or from Southeast Asia. It is an important marker bed in the Pleistocene work that can be used to date cultural remains, stone assemblages lying above and below the ash. Certainly the Acheulian at Bori is later than the ash which is dated to 1.4 Myr. But it is important to be able to show how much later the Acheulian is. It is a very nice material, relatively fresh. Especially interesting is the one flake which may well be artificial appears to come from a gravel below the ash. It is vital to excavate sections to expose the gravel under the ash to find more flakes and whether cultural material can be found in that gravel. If the flakes can be shown to be artificially produced by humans, it does show that hominids were present in that part of Asia more than 1.4 Myr. ago.

How did you come to archaeology ?

I had a grandfather who had strong antiquarian interests and perhaps it was out of this, nurtured by one or two superb teachers, that my own interest in Prehistory developed. My grandfather was a chemist. He travelled widely in the continent enjoying the classical antiquities. My father who took over the cosmetic business which my grandfather had patented and manufactured. One of my father's interest was in history. My brother, sister and I visited many a castle, monastery, roman villa or ancient hill fort. I was sent to Swanbourne House a preparatory school for Bradfield in Buckinghamshire. I passed the Common Entrance and went on to Monkton Combe School just outside Bath. Looking back on my time there, I cam see now that this is where I started to become what I am today and my archaeological interests began to form. I had a maths master, A.T. Wicks, who was a local antiquarian who did his best also to teach maths, a history master, Maurice Howells, who taught us to look for cause and effect and not just to memorise bare facts; and house master, A.F. Lace, outwardly austere, but who took a very real interest in all of us in his charge. At Monkton, a rowing school, I took part in Regatta and I continued to row at Cambridge and Livingstone, until 1961, when I came to Berkeley. It taught me good team work which is of the essence, whether in rowing or as part of an archaeological team in the field in Africa.

My interests at Monkton were in humanities, in history and things archaeological but not in classical languages which I was never much good at. I remember going to Sydney Smith, the Keeper of Egyptian and Assyrian antiquities at the British Museum, when I was around sixteen, to ask about job possibilities in Egyptology. I was told that unless I could be certain of a first in Greek and Latin I could forget about it - I did just that. Later I read history for two years and received a 2(2) in the Tripos and then went on to read the Archaeology and Anthropology Tripos under Miles Burkitt and Grahame Clark. This is where my interest began to form on prehistoric archaeology, in particular in the Palaeolithic.

What were the intellectual ferments of the time when you were beginning to be an archaeologist ?

Miles was a superb teacher, he had vast enthusiasm and was a born teacher who embellished his tutorials at Merton House with many an anecdote relating some prominent archaeologists or anthropologists. I was one of, I think six undergraduates that year; Charles McBurney was another and we became fast friends. If it was Miles who gave us enthusiasm, it Grahame who showed us the need for precision in archaeology; how to study an assemblage and, and what was most important, to study it within its environmental setting. For me, Grahame's emphasis on palaeo-ecology has been all important since, without an understanding of the habitat of any prehistoric group, it is impossible to understand their behaviourwhy particular resources were being used, why they chose to do so in the way they did and how the changes in climate and environment brought about the particular adaptation that resulted. Grahame gave us people, Miles instilled an interest in the artifacts through knowledge of those who dug them up and of the history of the discipline.

My fieldwork initiation was with Sir Mortimer Wheeler at Maiden Castle for the 1936 season and a shorter time in 1937. I have always been grateful for this introduction to the rigorous field methods he adopted. They certainly set a new standard in Britain and in India also, as I was able to see for myself a few years ago. I was put to work on Iron Age pits at Maiden castle with John Waechter, who had been working in the Middle East, as my supervisor; he was a kindly and stimulating instructor and we became lifelong friends.

The Zambezi valley gave me my first opportunity to apply what I had learnt at Cambridge and I was able work out the geomorphological sequence of terraces and their contained artifact assemblages and, more rarely, faunas. I had to relearn completely what a gravel deposit looked like, having been used to gravel pits 20-30 feet deep back in England. At the Falls, where the Zambezi was running over bedrock base we were faced with gravel of only two or three feet, or less. One outcome of this work at the Falls was that I was able to concoct a rough estimate of the rate of recession of the Falls through the gorges back to the present time based on the kinds of artifacts to be found abraded and left exposed on the old river bed as the falls receded upstream.

Godfrey Wilson was the Director of the joint Rhodes-Livingstone Institute and Museum and it was he and his wife Monica who gave a much deeper appreciation of what archaeologists could gain from ethnography and a deep interest in material culture and the way in which this, and the activities and people with which it is related, can provide the archaeologist with a basis for understanding how prehistoric people behaved.

In 1939, I reexcavated at Mumbwa, which was the first site ever to be excavated in Northern Rhodesia (Zambia) by F.B. Macrae, a District Commissioner, and also one of Miles Burkitt's student. I was able to define the Iron Age, Later and Middle Stone Age sequences but chiefly I had the opportunity to look at the ecology and possible seasonal occupation of the site since it lay in the ecotone between the plateau the savanna and the grasslands of the Kafue Flats. How much more we would have been able to know if the knowledge of game behaviour had been as good then as it is now.

You have had the longest record of doing Prehistory. In what ways the discipline has grown, especially in respect of concepts and methods, and how do you compare the conditions in terms of facilities available ?

Up to the 1940s and early 1950s, Palaeolithic archaeology followed more or less conventional lines. We concentrated mostly on the taxonomy of the artifacts and on obtaining stratified sequences that could be dated in relative terms only. Artifact assemblages were allocated to one or other of recognised industries, often ill-defined. There was more than an impression that artifacts might, as it were, breed and investigations would produce charts to show the evolution of a particular complex which was believed to be associated with a discrete group of people and so to be an expression of Culture. It took us quite sometime to realise that one cannot understand human cultural behaviour only on the basis of one small, often unimportant element of the material culture i.e. stone tools. Our concern was with relative chronology and with the typology of the artifacts themselves, in particular with what we believe 'type fossils'. We had little or no means of relating these artifacts assemblages to the hominids who made them and no means at all of estimating how long a period of time a particular industry or complex lasted. Everything was really imprecise and subjective. Almost every assemblage that we were looking at was in secondary context, unless it came from a cave or rock shelter, and even these were dug in spits of several centimeters so that we had no basis for beginning to decipher evidence for behaviour. In retrospect we can see that what we did fell far short of what we should have been doing but, without this basis in stratigraphy and taxonomy, prehistory would not be where it is.

Willard Libby gave us the radiocarbon method of dating in 1950. This gave us a method of correlation over wide distances. Later in the 1960s Potassium-Argon, Uranium-series, fission-track and Palaeomagnetic reversal chronology, were all available to us enabling us to show how long a prehistoric industrial tradition lasted in terms radiometric years. Thus relative chronology became a thing of past. One of the most significant findings to come out of the new chronology was the great time-depth of hominid evolution.

In Africa, our problem was of lack of precision in definition and, indeed, in understanding where we were going. There were quite a number of amateur archaeologists in South Africa, and relatively few in most other parts of

Africa south of the Sahara and even fewer professionals. Foreign teams had started working and some valuable site excavation reports were available by mid 1960s. In addition to being able to show how long a prehistoric cultural tradition lasted in terms of radiometric years, it was possible to see the length of time it took for one biological hominid stage to evolve into another. The radiometric chronology was well underway and the time was ripe to introduce some rigour into African archaeology. In 1967 we published *Background to Human Evolution in Africa.* This contains a wealth of information and places on record where we were, how much ambiguity we were working with and where and how it seemed important to try to introduce some precision. Our recommendations received general recognition especially in regard to the need for precise definition of industrial entities and of boundaries whether they be stratigraphic or cultural. The hierarchy of terms is now in general use in the continent.

In the late 1940s, when the Leakeys excavated at Olorgesaillie it turned a new leaf in African Prehistory. Here, finegrained, old lake and fluvial sediments sealed a series of Acheulian cultural horizons, either on palaeosols or in shallow, low energy stream channels. The cultural material had suffered minimal disturbance from the time the site was abandoned until it became sealed by lake sediments. This gave us the added dimension of space and it was possible to study association between different kinds of artifacts and bone waste which is generally well preserved in the rift valley sites. We had a viable basis for beginning to say something about the activities represented by these artifacts and bones and so to try to look at the behavioural strategies of the early hominids.

The 1950s saw the beginning of Primate behaviour studies which have led us to the understanding of Primate behaviour that has been so vitally important for providing insight into the behaviour of the first protohumans the australopithecines and *Homo habilis.* By the late 1960s, with the greater emphasis on ecology and its significance for understanding dynamic systems of human behaviour, an attempt was being made to look at the distribution of different prehistoric traditions in relation to past changes in these patterns that reflected the onset of glacial and intellectual conditions in the high latitudes.

The *Early Man/Africa Programme* at Berkeley has produced a number of outstanding prehistorians who are working on the special problems relating to recognition of the evidence of the activities of prehistoric peoples and how to distinguish these from the marks of other animals or of geological agencies. From a state of naivete in seeing any association of artifacts and broken bones as being due to hominids, an appreciably more cautious approach is now used so that ascription to hominid activity is only made after other possible agencies can be eliminated and much of the new understanding that is coming about is due to the prehistorians trained in the Berkeley Programme.

Interpretations must change as new data and new techniques become available; and certainly who would have thought, any time in the 1930s, that we would have been able to know one quarter of what we know today ? And who, even 15 years ago, would have thought it would be possible to determine dietary preferences from abrasive pattern on the occlusal surfaces of teeth; from oxygen and nitrogen isotope studies to show how much marine food there was in the diet of a prehistoric population and whether the terrestrial animals they were taking were primarily grazers or browsers? Determination of whether stone and bone have been burned and the temperature to which they have been subjected is now possible and is crucial for understanding when it was that the hominid lineage first made regular use of fire, since very ancient sites in the open no longer preserve charcoals. Polishes on the edge of stone tools as much as 1.5 million years old are still identifiable as having been produced by use on different substances - soft plant remains, wood and meat, for example — and I would predict also that it will not be too long before we are able to identify organic traces on the working edges of stone tools.

How do you like doing archaeology?

I find it very enthralling. I enjoyed the pleasure of discovery, I enjoyed the pleasure of trying to understand the meaning of jumbles of stones, bones and other features at archaeological sites that I excavated.

Over the years you have authoritatively traced the origins and development of cultures. Progress of the past societies had been slow and steady and at times more adaptive to the environment. In this regard, the contemporary societies with their superior technology present a direct contrast. There is a tremendous increase in the rate at which these societies are changing: where does this take us?

Either it leads the world to blotting ourselves out or it leads to a control of technology that can be used to the benefit of humanity and other associated forms of life on this planet so that it may persist.

Thank You.

Book-Review

Rural Life and Folk Culture in Ancient India. Edited by U.N. Roy, V.D. Misra and J.N. Pandey, Department of Ancient History, Culture and Archaeology, University of Allahabad, Allahabad. 1988, pp. 148. Rs. 250.

This book presents the proceedings of a seminar on **Rural Life and Folk Culture in Ancient India** held in February 1985 at the Department of Ancient Indian History, Culture and Archaeology, Allahabad University, Allahabad. The Department had planned three seminars focusing on the Forest, Rural, and Urban ways of life in ancient India. Two of these seminars have been held but this is the first of the proceedings to be published. This volume represents the first serious step towards understanding the complex processes and antecedents that led to the establishment of city life in ancient India. A noteworthy feature of this volume is that it provides new ideas on the theoretical aspects and methods that are being employed in the study of the transition from the forest to the village and from the village to an urban way of life.

The volume contains seventeen papers which cover a very wide spectrum of themes and time periods. The papers can be broadly grouped into three sections: the first section deals with the theoretical underpinnings, the second focuses on the pre- and protohistoric contexts, and the third examines the study of historical processes based on literary and epigraphical material.

Dilip K. Chakrabarti attempts a theoretical exposition of the issues involved in the study of urbanisation processes and laments the singular lack of indigenous models. He further states that trade, iron-technology, etc. need not be taken as the hallmark of urbanisation, and supports his argument by referring to the inferences drawn by Makkhan Lal in the context of settlement archaeology of the Kanpur district in U.P., and the work of Suraj Bhan and Jim Shaffer in Haryana. He makes out a case for the Painted Grey Ware sites as representing the village bases which grew into urban centres during the 6th century B.C. i.e. the N.B.P. period.

Shivaji Singh's thought provoking article discusses the pros and cons of the validity of the 'resource scarcity model' in the context of the Mesolithic culture of the middle Ganga valley and argues in favour of the 'ethnoethological model' to explain the seasonal migration of the Mesolithic communities.

Under the title *Aṭavikas* (literally forest dwellers), K. D. Bajpai discusses the entire gamut of archaeological evidence in Central India and traces the beginning of settled life to the earliest levels at Kayatha. On the basis of the study of cave paintings, he surmises that the cave and rockshelter dwellers had established an exchange network with the farming settlements in the plains of the Narmada, Betwa, Chambal and other river valleys in Malwa. In addition, he gives an account of village life as gleaned from the Epics and classical literature.

D.N. Tripathi makes an interesting study of pit-dwellings in the ancient world in general and India in particular. He traces the antiquity of pit dwellings to the Upper Palaeolithic and states that they became a common method of protection from wind and other vagaries of climate in Neolithic times and continued to be in use in the Chalcolithic period. He cites evidence from Vedic literature and Panini's *Aṣṭadhyāyi* for the persistence of pit dwelling into historical times as well.

U.N. Roy makes an in-depth study of the *Aṣṭadhyāyi* of Panini for rural-urban differentiation. He comes to the conclusion that as early as the 5th century B.C. there existed a clear-cut distinction between *grāma* (village) and *nagara* (city), the village representing a cluster of agriculturists and the city an agglomeration of industrial and commercial communities.

The articles by J.N. Pal, J.N. Pandey and V.D. Misra trace the origin of the semi-sedentary settlements during the terminal Stone Age and Chalcolithic period and their subsequent growth into village bases and eventual efflorescence as urban centres in the region north of the Vindhyas. Their articles usefully summarise the results of prehistoric research carried out by the archaeologists of Allahabad University during the last twenty-five years in the Vindhyas and the adjoining Ganga valley.

Papers by Sandhya Mukerjee and S.N. Roy look into the sculptural and epigraphical data their bearing on the urbanisation processes. Other papers by R.N. Nandi, J.M. Rai,

S. Bhattacharya, Om Prakash and Anupa Pande examine the literary evidence its bearing on early rural and urban communities. These articles considerably widen the scope of this volume.

There are some discrepancies in the use of diacritical marks and also some gaps and inaccuracies in the references. The value of the papers would have been enhanced if the authors had given a comprehensive bibliography instead of the select few references listed. The volume would also have benefitted from a thematic and chronological arrangement of the articles. These shortcomings, however, do not detract from the strength and usefulness of the volume. The editors deserve our congratulations and gratitude for the excellent job they have done. One hopes that the remaining two volumes will be brought out without much delay and with the papers organised in a more coherent pattern.

V.N. Misra

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Indian Society for Prehistoric and Quaternary Studies

c/o Department of Archaeology
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Report of the General Secretary for 1988-89 (1.7.1988 to 31.3.1989)

The year was particularly eventful in the career of the Society in respect of the augmentation of its financial resources, improvement in the quality and increase in the frequency of its journal, increase in the members' participation in the conference, better organisation of the conference, and enrolment of new Life Members. The details are given below:

Man and Environment

Volume XIII of **Man and Environment** was published in the first week of December 1988 on the occasion of the annual conference of the Society. The journal has been printed by the photo offset method and has a considerably improved format. This method will be used for future issues as well. Beginning with this issue, the editing, printing and distribution (for Life Members only) of the journal is being done from Pune. The availability of more editorial expertise and manpower as also the facility of a word processor at Pune have made it possible to substantially improve the quality of the journal in terms of editing and proof-reading. In particular, Dr. Statira Wadia, Dr. Ravi Korisettar and Shri R.K. Ganjoo have put in an enormous amount of labour on the journal. The work involves reading the manuscripts several times, frequent correspondence with the authors to ask for missing or incomplete information, typing the manuscripts on the word processor and inserting the corrections to make the manuscript flawless in all respects. In addition, there are repeated visits to the press to deliver the MS and then to collect and read the proofs. Dr. Korisettar, has recently moved to Karnatak University, Dharwad, yet he continues to shuttle between Dharwad and Pune to look after the editorial work.

We have also been lucky to find a very capable and conscientious printer in Shri Sujit Patwardhan of Mudra press in Pune. Shri Patwardhan is taking keen personal interest in improving the quality of the journal in respect of layout, style, language, proof-reading, and overall printing.

The quality of the journal in its new form in respect of contents and printing has won appreciation from members and other readers. It will be our endeavour to keep improving it steadily.

Annual Conference

The XVIth Annual Conference of the Society was held under the auspices of the Department of Ancient Indian History, Culture and Archaeology, Visva- Bharati, Santiniketan on 1-3 December, 1988. Dr. S. Chakrabarti of the same Department acted as Local Organising Secretary. The quiet, green campus of the University provided an ideal atmosphere for the conference. The conference was inaugurated by Prof. Nemai Sadhan Bose, Upacharya of the University. The Upacharya, Prof. N.C. Ghosh, his colleagues and students in the Department took every care to make the stay of the participants in the campus a comfortable, happy and memorable experience.

Following members participated in the conference:

1. Shashi Asthana, 2. G.L. Badam, 3. Tulika Banerji,
4. P.K. Behera, 5. S. Chakrabarti, 6. P.G. Chatterje,
7. Dipankar Chaudhuri, 8. Sumat Chaudhury, 9. G. Corvinus,
10. Meenakshi Dubey, 11. A.K. Ghosh, 12. S.P. Gupta,
13. Kirti Jain, 14. Vidula Jayaswal, 15. M.D. Kajale,
16. Ravi Korisettar, 17. Giriraj Kumar, 18. Ravindra Kumar,
19. Makkhan Lal, 20. Sudha Malaiya, 21. R.N. Mehta,
22. A.K. Misra, 23. V.D. Misra, 24. V.N. Misra,
25. Malti Nagar, 26. Jeetendra Nath, 27. J.N. Pal,
28. R.K. Pancholi, 29. B.M. Pande, 30. J.N. Pandey,
31. R.P. Pandey, 32. S.K. Pandey, 33. Suman Pandya,
34. P. Vijaya Prakash, 35. B. David Raju, 36. Ranjana Ray,
37. M.D.N. Sahi, 38. Aparna Sengupta, 39. R.K. Sharma,
40. Gopal Shesh, 41. P.K. Shukla, 42. B.P. Singh,
43. B.P. Sinha, 44. S.P. Sinha, 45. V.H. Sonawane,
46. E.J. Sireesha, 47. Suryakant Srivastava,
48. B.R. Subrahmanyam, 49. Rakesh Tiwari,
50. Alok Tripathi, 51. Gayatri Tripathi, 52. J.D. Tripathi,
53. G.S. Tyagi

As in previous years, the conference had a seminar session and an open session. The topic of the seminar this year was **Hunter-Gatherer Adaptations during the Holocene.** The following papers were presented in the seminar and open sessions.

Seminar Session

V.N. Misra: Demographic, Economic and Social Implications of Early and Middle Holocene Archaeological Data

M.D. Kajale: Palaeobotanical Evidence for Mesolithic Plant Economy from Excavations at Damdama, District Pratapgarh, Uttar Pradesh

Vidula Jayaswal: Mesolithic Adaptation in Eastern India: A Case Study of Paisra

Ranjana Ray & A.K. Ghosh: Iso-Types of Early Holocene Industries: Studies on Adaptation Determinants

V.N. Misra & Suman Pandya: Mesolithic Occupations around Dhansura, District Sabarkantha, Gujarat

Gayatri Tripathi: Experimental Samples vis-a-vis some Microliths from Mirzapur. A Study in Microwear Correlation

Malti Nagar: Kanjars a Hunting-Gathering Community of the Ganga Valley

P.G. Chatterji: Some Food Materials of the Hunter-Gatherer — An Assay on Contents

D.Chaudhuri & A.K. Ghosh: Biocultural Adaptations of the Hunter-Gatherer: Projection from Present to Past

Kirti Jain: Son Kolis Their Ritual Practice and Significance

G.S. Tyagi: Earliest Rock Paintings: A New Concept from the Rock Paintings of Source Region of River Betwa

J.D. Tripathi: Narsinghgarh ke Shialshrayin Abhilekh

Open Session

G. Corvinus: Prehistoric Hunter-Gatherers in the Siwaliks in Nepal

V.N. Misra, S.N. Rajaguru, G.L. Badam, R.K. Ganjoo & Ravi Korisettar: Further Research in the Prehistory and Quaternary Geology of the Narmada Valley

R.P. Pandey: Late Pleistocene Fossils and Middle Palaeolithic Industries of the Upper Parvati Valley, Central India

Giriraj Kumar: Ostrich Egg to the Prehistoric Man: Some More Evidences from Chambal Valley

G.L. Badam & V.G. Sathe: Geological and Biological Implications of the Ostrich in India with Reference to its Importance in Archaeological Context

P. Vijaya Prakash: Prehistory of Eastern Ghats: An Ethnoarchaeological Report

A.K. Misra: Microlithic Elements in Upper Palaeolithic around Karvi, District Banda

Tulika Banerji: Ritualistic Behaviour of Prehistoric People

Ranjana Ray: Pottery Technology and its Socio-Economic Implication in Eastern India

P.K. Behera: Bonaigarh: A Manufacturing Centre of Neolithic Celts in Orissa

V.H. Sonawane: Excavation at Nagwada 1987-88: A Preliminary Report

Neena Thakur: Bone Tools from Early Senuwar

B.P. Singh: Early Farming Communities of Kaimur Foothills

Ravindra Kumar: An Archaeological Reconnaissance of the Middle Gomti Basin Dispersal of Settlements

S. Chakrabarti: Archaeology of Khiching: Recent Research and Retrospect

Life Members

The increase in Life Members was the highest in any single year in the sixteen-year life of the Society. The following forty-two scholars joined the Society's family of Life Members.

1. Shashi Asthana, 2. P.G. Chatterjee, 3. Sumat Chaudhary,
4. Hemangi Deodhar, 5. B.C. Deotare, 6. Meenakshi Dubey,
7. P.B. Gambhir, 8. Savita Ghate, 9. V.D. Gogte,
10. Jacob S. Jayaraj, 11. V.S. Kale, 12. Anupama Kshirsagar,
13. Ravi Korisettar, 14. P.R. Kulkarni, 15. Ravindra Kumar,
16. Deepika Kundaji, 17. R.N. Mehta, 18. Jaya Menon,
19. Sheila Mishra, 20. R.K. Mohanty, 21. Jeetendra Nath,
22. R.K. Pancholi, 23. B.M. Pande, 24. R.S. Pappu,
25. S.N. Rajaguru, 26. K. Rajan, 27. M.D.N. Sahi,
28. Aparna Sengupta, 29. Gopal Shesh, 30. Bhagwan Singh,
31. Bhupendra Pal Singh, 32. K.M. Shrimali, 33. P.K. Shukla,
34. Suryakant Srivastava, 35. P.C. Venkata Subbaiah,
36. B.R. Subrahmanyam, 37. Rakesh Tiwari,
38. Alok Tripathi, 39. Gayatri Tripathi, 40. J.D. Tripathi,
41. G.S. Tyagi, 42. Statira Wadia

Meeting of the Executive Committee of the Society

Minutes of the meeting of the Executive Committee held at 8 p.m. on 2. 12. 1988 at Visva-Bharati, Santiniketan

Following members were present

1. S.P. Gupta
2. V.N. Misra
3. G.L. Badam
4. V.H. Sonawane
5. Ravi Korisettar

Dr. S.P. Gupta chaired the meeting in the absence of the Society's Chairman, Prof. B.B. Lal.

The following resolutions were proposed, and subsequently adopted unanimously at the meeting.

1. The name of Prof. B.L.K. Somayajulu, Physical Research Laboratory, Ahmedabad be proposed as the President of the Society for 1989.
2. The invitation of Prof. B.R. Subrahmanyam, Head of the Department of Ancient Indian History, Culture and Archaeology, Nagarjuna University, Nagarjuna Nagar to host the XVIIth Annual Conference of the Society under the auspices of his university be accepted.
3. The subscription for annual membership of the Society be raised to Rs. 100.00 for Indian, and US $ 20.00 for foreign scholars from the present Rs. 40.00 and US $ 10.00 respectively.
4. The subscription for Life Membership of the Society be raised to Rs. 600.00 for Indian, and US $ 150.00 for foreign scholars from the existing Rs. 400.00 and US $ 100.00 respectively.
5. The bulk of the Ford Foundation grant of US $ 45,000.00 given to the Society be invested in corporations/companies controlled by the Government of India like the Unit Trust of India and Steel Authority of India.
6. **Man and Environment,** the journal of the Society, be published twice a year, in June and December, instead of annually as at present.
7. The present Editorial Committee comprising V.N. Misra, S.N. Rajaguru, Statira Wadia, Ravi Korisettar and R.K. Ganjoo be continued.
8. Referees of manuscripts submitted for publication in **Man and Environment** be paid a token honorarium of Rs. 100.00 per manuscript.

The meeting ended with a vote of thanks to the Chair.

V.N. Misra
General Secretary

Read and confirmed

Sd/-
S.P.Gupta
Chairman

Meeting of the General Body of the Society

Minutes of the Business Meeting of the General Body held at 4.00 p.m. on 3.12.1988 at Visva-Bharati, Santiniketan

Following members were present

1. I.H. Ansari, 2. Shashi Asthana, 3. G.L. Badam,
4. S. Chakrabarti, 5. P.G. Chatterjee,
6. Deepankar Chaudhuri, 7. G. Corvinus,
8. Meenakshi Dubey, 9. A.K. Ghosh, 10. N.C. Ghosh,
11. S.P. Gupta, 12. Kirti Jain, 13. M.D. Kajale,
14. Ravi Korisettar, 15. Giriraj Kumar, 16. Makkhan Lal,
17. R.N. Mehta, 18. V.D. Misra, 19. V.N. Misra,
20. Malti Nagar, 21. J.N. Pal, 22. R.K. Pancholi,
23. J.N. Pandey, 24. R.P. Pandey, 25. S.K. Pandey,
26. Suman Pandya, 27. P. Vijaya Prakash, 28. B. David Raju,
29. Ranjana Ray, 30. Aparna Sengupta, 31. Gopal Shesh,
32. P.K. Shukla, 33. B.P. Singh, 34. B.P. Sinha,
35. S.P. Sinha, 36. V.H. Sonawane, 37. J.D. Tripathi,
38. G.S. Tyagi, 39. T.P. Verma

Prof. B.P. Sinha presided over the meeting in the absence of the Society's Chairman, Prof. B.B. Lal.

At the outset the General Secretary presented his report for the year 1987-88 (1.7.1987 to 30.6.1988). The report was unanimously accepted.

Following resolutions of the Executive Committee were put forward before the General Body, and they were unanimously approved.

1. The name of Prof. B.L.K. Somayajulu, Physical Research Laboratory, Ahmedabad be proposed as the President of the Society for the year 1989.
2. The invitation of Prof. B.R. Subrahmanyam, Head of the Department of Ancient Indian History, Culture and Archaeology, Nagarjuna University, Nagarjuna Nagar to host the XVIIth Annual Conference of the Society under the auspices of his university be accepted.
3. The subscription for annual membership of the Society be raised to Rs. 100.00 for Indian, and US $ 20.00 for foreign scholars from the present Rs. 40.00 and US $ 10.00 respectively.
4. The subscription for Life Membership of the Society be raised to Rs. 600.00 for Indian, and US $ 150.00 for foreign scholars from the existing Rs. 400.00 and US $ 100.00 respectively.
5. The bulk of the Ford Foundation grant of US $ 45,000.00 given to the Society be invested in corporations/companies controlled by the Government of India like the Unit Trust of India and Steel Authority of India.
6. **Man and Environment,** the journal of the Society, be published twice a year in June and December instead of annually as at present.

7. The present Editorial Board comprising V.N. Misra, S.N. Rajaguru, Statira Wadia, Ravi Korisettar and R.K. Ganjoo be continued.
8. Referees of manuscripts submitted for publication in **Man and Environment** be paid a token honorarium of Rs. 100.00 per manuscript.

The meeting ended with a vote of thanks to the Chair.

V.N. Misra
General Secretary

Read and confirmed

Sd/-
B.P. Sinha
Chairman

Finances of the Society

The Society received grants of Rs. 15,000.00 each from the Archaeological Survey of India and the Indian Council of Historical Research for the publication of Vol. XIII of **Man and Environment** and a grant of Rs. 7,500.00 from the Indian Council of Historical Research for organising the seminar on **Hunter-Gatherer Adaptations during the Holocene**. An audited statement of the Society's accounts is presented on the following pages.

I would like to report here the action taken on Resolution No. 5 of the Executive Committee meeting and of the General Body meeting. It was decided under this Resolution that the bulk of the funds from the Ford Foundation grant be invested in Government-controlled corporations/companies. However, I consulted the Ford Foundation in this matter, and they advised that the funds should be invested only in nationalised banks. Accordingly, we have kept the funds in fixed deposits in the Central Bank of India, Pune.

Sd/-
V.N. Misra
General Secretary

INDIAN SOCIETY FOR PREHISTORIC AND QUATERNARY STUDIES

C/o Department of Archaeology, Deccan College, Pune 411 006

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31.03.1989

Expenditure		Amount	Income		Amount
Establishment Exps.			Bank Interest		37,342.58
Bank Commission	1,134.50		**Grants**		
Honorarium	300.00		ICHR for Conference		7,125.00
Postage	696.25		Grant for M & E		15,000.00
Travelling	230.60		**Other Income**		
Accounting Charges	900.00		Life Membership fee	16,820.00	
Printing	2,357.00		Cost of reprints	795.00	
		5,618.35	Royalty	4,304.00	
			Subscription	690.00	
Audit fees		1,000.00			22,609.00
Contribution		296.95			
Miscellaneous Exps.		77.20			
Depreciation					
Furniture		264.50			
Expenditure on object of the Trust					
Pub.of M&E	30,745.00				
Conference Exps.	8,053.20				
		38,798.20			
Surplus transfer to Balance Sheet		36,021.00			
		82,076.00			82,076.00

(Dr. V.N.Misra)
General Secretary

(R.K. Ganjoo)
Asst.Secretary

(Dr. P.K. Thomas)
Treasurer

R.B. Mote & Co.
Chartered Accountants

INDIAN SOCIETY FOR PREHISTORIC AND QUATERNARY STUDIES

C/o Department of Archaeology, Deccan College, Pune 411 006

BALANCE SHEET AS AT 31ST MARCH 1989

LIABILITIES		Amount	INCOME		Amount
Other Earmarked Funds		6,08,108.10	**Investments**		
Liabilities for Expenses			F.D.R. with Central		
Dilip Chakrabarti	18,115.00		Bank of India		6,16,000.00
D. Shah	51.00		**Furniture & Fixtures**		2,380.50
S.P. Gupta	178.69		**Income Outstanding**		
R.B.Mote & Co.	1,900.00		Accrued Interest on F.D.R.		20,052.08
		20,244.69			
Income & Expenditure A/c			**Cash & Bank Balance**		
As per last B/S	61,886.55		A/c No.717	5,550.73	
Add: Surplus	36,021.38		A/c No.2107	82,531.45	
		97,907.93	Cash in hand	339.90	
					88,422.08
		7,26,854.66			7,26,854.66

(Dr. V.N. Misra) **(R.K. Ganjoo)** **(Dr. P.K. Thomas)**

R.B. Mote & Co.
Chartered Accountants

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